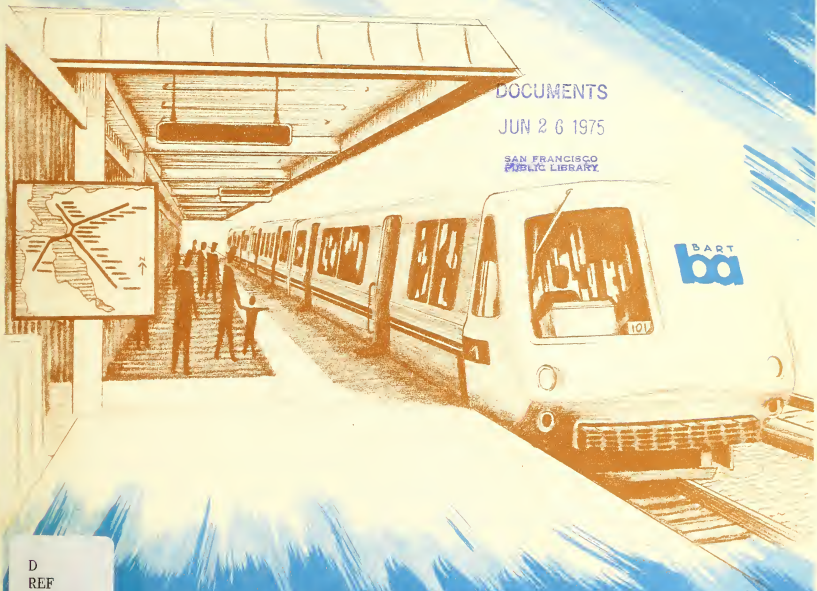
bart impact program

IMMEDIATE TRAVEL IMPACTS OF TRANSBAY BART



The BART Impact Program is a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART).

The program is being conducted by the Metropolitan Transportation Commission, a nine-county regional agency established by state law in 1970.

The program is financed by the U. S. Department of Transportation, the U. S. Department of Housing and Urban Development, the National Science Foundation, and the California Department of Transportation. Management of the Federally-funded portion of the program is vested in the U. S. Department of Transportation.

The BART Impact Program covers the entire range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors will be measured and analyzed. The benefits of BART, and their distribution, will be weighed against the negative impacts and costs of the system in an objective evaluation of the contribution that the rapid transit investment makes toward meeting the needs and objectives of this metropolitan area and all of its people.

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IMMEDIATE TRAVEL IMPACTS OF TRANSBAY BART

MAY 1975

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16. Abstract

The Bay Area Rapid Transit (BART) System started service beneath San Francisco Bay in September 1974. This report analyzes travel patterns in the transbay corridor in the period before and immediately after the start of transbay BART service. Aggregate transbay travel by automobile and transit are analyzed in terms of historical trends and seasonal and short-term variations as the basis for assessing the impacts of BART. Impacts on traffic congestion are analyzed using highway travel time survey data. The results of on-route questionnaire surveys of transbay travelers using automobile, BART, and bus in October 1974 provide descriptions of the origin-destination pattern of transbay trips, their purposes, and the profiles of travelers. Traveler choices between BART and the alternative modes are analyzed in terms of reported travel times and costs and ratings of perceived importance and satisfaction for a set of 14 travel factors (impedances) included in the survey questionnaire.

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TRANSPORTATION SYSTEM AND TRAVEL BEHAVIOR PROJECT

BART IMPACT PROGRAM

DOCUMENT NUMBER TM 15-3-75
PREPARED BY PEAT, MARWICK, MITCHELL & CO.
UNDER CONTRACT WITH THE METROPOLITAN TRANSPORTATION COMMISSION
FOR THE U.S. DEPARTMENT OF TRANSPORTATION, OFFICE OF TRANSPORTATION
PLANNING ASSISTANCE, AND URBAN MASS TRANSPORTATION ADMINISTRATION
UNDER CONTRACT DOT-OS-30176, TASK ORDER 3,
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PREFACE

The analyses and conclusions presented in this report were largely based on the results of a program of questionnaire surveys undertaken as part of the Transportation System and Travel Behavior (TSTB) Project of the BART Impact Program. The surveys were conducted by Market Facts, Inc., Chicago, Illinois, under the direction of Mr. Richard Ross and Mr. Frank Griffiths. In the report, the surveys are referred to as "BART Impact Program, October 1974 Surveys of Transbay Travel." Details of the methodologies employed in conducting these surveys are given in a separate report of the TSTB Project.*

Extensive information from other sources was also analyzed. These sources included counts of highway vehicle traffic, counts of bus and BART ridership, highway travel time surveys, and the results of previous questionnaire surveys of BART ridership. Among Peat, Marwick, Mitchell & Co. staff members who assembled and analyzed these data were Dr. Henry Fan and Mr. Stephen Cohn.

In the course of assembling and analyzing all the above data, cooperation and assistance was provided to the TSTB Project team by many individuals and organizations. These included:

- Dr. Henry Bain, Mr. Joel Markowitz, and other members of the Metropolitan Transportation Commission BART Impact Program staff.
- Ms. Miriam Hawley and other staff members of the Bay Area Rapid Transit District.
- Professor Wolfgang Homburger and Mr. Richard Fain of the Institute of Transportation and Traffic Engineering at the University of California, Berkeley.
- Mr. Steven Ito of the Toll Bridge Administration, California Department of Transportation.
- Mr. Keith Marolt and Mr. Scott McCalden of the California Department of Transportation, District 4.
- Mr. Richard Videll of the Alameda-Contra Costa Transit District (AC Transit).

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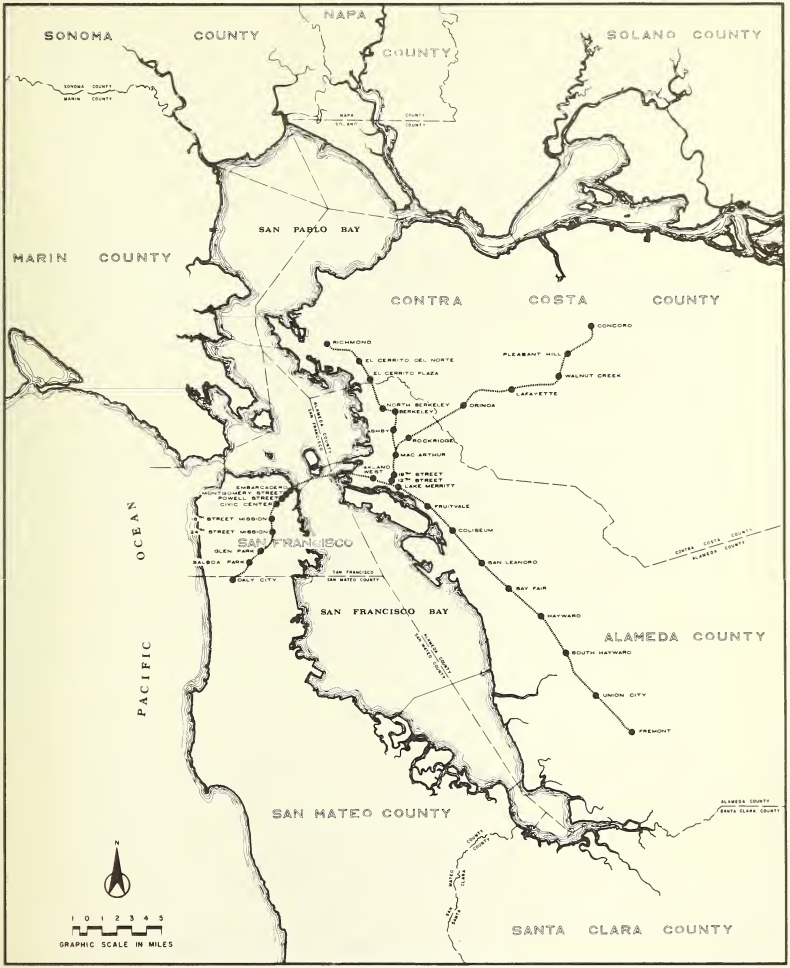
*"Surveys of Transbay Travel, October 1974: Data Collection Methodology," BART Impact Program Document Number DD 4-3-75, prepared by Peat, Marwick, Mitchell & Co., Burlingame, California, for the Metropolitan Transportation Commission, Berkeley, California, May 1974.

- Mr. A. R. Cianfichi of Greyhound Lines West.
- Mr. Gerald Kauthen of the San Francisco Municipal Railway (MUNI).

The many contributions of the above individuals and organizations are gratefully acknowledged. Special thanks are due to staff members of the Metropolitan Transportation Commission BART Impact Program for their helpful and constructive comments on an earlier draft of this report. However, responsibility for its contents rests entirely with Peat, Marwick, Mitchell & Co.



BAY AREA RAPID TRANSIT SYSTEM

PEAT, MARWICK, MITCHELL & CO.
SAN FRANCISCO

SUMMARY

Transbay Travel

In September 1974, the Bay Area Rapid Transit (BART) System started service from San Francisco to Oakland and the other "East Bay" cities in Alameda and Contra Costa Counties. Although BART is still at an interim stage in its development, the start of service through the "Transbay Tube" was a major step towards full operation of the 71-mile System. The addition of the transbay link increased ridership on the System from an average of about 70,000 trips a day to over 120,000 trips a day. Thus, BART ridership across the Bay accounted for about 43% of total BART System ridership. These transbay BART trips represented about 19% of the total trips made in the heavily traveled San Francisco-Oakland Bay Bridge corridor. Six weeks after the start of BART service, about 136,000 daytime person-trips were made by automobile, BART, and bus each weekday from San Francisco to Oakland in the corridor; of these, about 92,000 (68%) were made by automobile; 26,000 (19%) by BART; and 18,000 (13%) by bus.

Study Objectives

The purpose of this study was to assess the transportation impacts that occurred as a result of the start of transbay BART service and the accompanying changes in travel patterns. To this end, a series of surveys of transbay travel were conducted at the end of October 1974, some six weeks after the start of service. Principal among these were "on-route" mail-back questionnaire surveys of a sample of 6,000 weekday transbay trips made by BART, bus, and private automobile across the Bay Bridge. This report presents the findings of these on-route surveys together with analyses of data from a comprehensive series of highway traffic counts, highway travel time surveys, and counts of BART and bus ridership.

Bay Bridge Traffic Volumes

Perhaps the most heralded impact of transbay BART service was the expectation that it would reduce highway traffic volumes on the congested San Francisco-Oakland Bay Bridge. In order to estimate the traffic reduction associated with BART's opening, changes in Bay Bridge traffic volumes were analyzed over the four years 1971 to 1974. The analysis attempted to take into account the several components of changes in traffic volumes: (1) day-to-day variations, (2) recurrent annual seasonal variations, (3) long-term trends in traffic growth, (4) recent modifications to the long-term trend caused by factors other than BART, and (5) changes brought about by BART. Linear regression analysis of average weekday traffic volumes over the years 1971 to 1973 was used to estimate the long-term trend and seasonal components of variation. The regression model was then used as the basis for prediction of traffic levels in the post-BART (October 1974) period. Comparison of the actual and

predicted traffic levels led to the conclusion that there had been a significant reduction in Bay Bridge traffic over the previous year. However, analysis of changes in traffic on other highways over the same period suggested that only a part of the apparent reduction in Bay Bridge traffic could reasonably be attributed to BART. In the year prior to the start of transbay BART service, there were serious gasoline shortages and an associated 50% increase in the price of gasoline in late 1973 and early 1974. These, together with a rising unemployment rate and general economic recession probably served to reduce traffic levels significantly. This leaves the conclusion that the reduction in Bay Bridge vehicle traffic attributable to BART was no more than about 2,000 vehicles a day in each direction, or 2% of the total daily volume.

This reduction must be considered in the context of the other sources of variations in Bay Bridge traffic. For example the difference in total daily vehicle traffic between Monday and Friday was typically about 14,000 vehicles; over the period 1971 to 1973, average daily traffic in January was 6,000 vehicles less than in July. Over the period 1971 to 1973, Bay Bridge traffic also exhibited a steady upward trend of about 2,000 daily vehicles or 2% per annum. In this context, the reduction of 2,000 vehicles per day in traffic on the Bay Bridge that can reasonably be attributed to BART must be considered small--on the order of one year's recent secular growth.

Bay Bridge Peak Period Traffic Congestion

In October 1974, most of BART's transbay ridership occurred during the peak periods, traveling westbound in the morning and eastbound in the evening. For example, 53% of BART's eastbound ridership occurred in the three hours from 3:00 p.m. to 6:00 p.m. Since much of this ridership was diverted from automobile, it was expected that BART's impact on Bay Bridge traffic levels would be most apparent during the congested peak periods. However, traffic levels at the busiest hours showed only small reductions. This is evidenced by an increase in average speeds through the Bay Bridge toll plaza from about 15 mph at the busiest time of the morning peak (7:30 a.m.) in April 1974 to an average of about 18 mph at the same time of day in October 1974.

A more marked change was a shortening of the period over which very high traffic levels occurred, suggesting that drivers had taken advantage of the relief in traffic congestion effected by BART by traveling at more desirable times (either earlier or later) than before.

Sources of Trip Diversion to BART

Six weeks after the start of service, westbound transbay BART ridership was at a level of about 25,000 daily trips. The survey results indicated that about 54% of these trips had previously been made by bus, 35% had previously been made by automobile and 11% were trips not previously made. Corresponding to this increase of 25,000 trips on BART, bus ridership during the hours of BART operation (6:00 a.m. to 8:00 p.m.) was reduced by about 13,000 trips to 18,000 daily trips. This drop in ridership was accompanied by corresponding

reductions in bus service. Automobile travel was reduced by about 3,000 person-trips to 93,000 trips during the same 14-hour period. Taken together, these changes show a net increase of about 9,000 daily westbound transbay person-trips. Of these, 2,000 were apparently new trips being made on BART; the remainder, or 7,000 daily trips, were apparently new automobile trips.

Induced Bay Bridge Automobile Trips

Available evidence points to the conclusion that the 7,000 new automobile trips were a result of the start of transbay BART service. By diverting substantial automobile traffic, BART effectively increased the highway capacity of the San Francisco-Oakland Bay Bridge and, thereby, reduced congestion. This, in turn, improved highway accessibility and induced significant numbers of transbay trips by automobile--trips which probably would not have been made as frequently had BART not started service. This conclusion is supported by some evidence which suggests that traffic volumes and congestion have gradually increased in the period since the opening of transbay BART.

Growth in Bay Bridge Traffic Since Transbay BART

Peak period traffic congestion apparently decreased significantly immediately after the start of transbay service on September 16. However, congestion appears to have increased in succeeding months to a year-end level quite similar to the level before the start of transbay service. On the Bay Bridge, a set of traffic lights meter traffic entering the bridge lanes from the toll plaza approach. These lights are controlled automatically by the speed of vehicles entering the bridge; thus the duration of the period over which the metering system is in operation indicates the length of the congested period.

In the three months between the start of transbay service and the end of the year, the average periods of activation of the metering system for midweek traffic were 52 minutes in October, 75 minutes in November, and 83 minutes in December. Statistically speaking, the latter figure is not significantly different from the mean of 88 minutes estimated for the period from March to June. This is consistent with the finding that 24-hour traffic on the Bay Bridge may have increased by as much as 2,000 vehicles over the period from October to December 1974.

Transbay Trip Purposes

The majority of transbay trips (62% or approximately 85,000 trips in each direction) were between home and work. Of these, approximately 52,000 trips (62%) were made by automobile, 18,000 (21%) by BART, and 15,000 (17%) by bus. Trips between home and work also formed the predominant trip purpose for transbay BART travel--the 18,000 daily trips between home and work made up 68% of all transbay BART trips--and a further 10% of trips were made for

other work-related purposes. Trips to or from school or college made up 10%, while shopping trips comprised only 3% of all transbay BART trips.

The predominant pattern of work travel was between residences in the East Bay and work places in San Francisco, with about 16,000 daily trips typically made. Relatively few (about 2,000) of these were made between residences in San Francisco and work in the East Bay. Transbay travel was very heavily oriented to downtown San Francisco locations. About 23,000 trips or 86% of BART's total transbay ridership was made to and from the 3 downtown BART stations. Much of this ridership was between downtown San Francisco and the middle and upper income residential areas of central Contra Costa County (the Concord Line). Forty-four percent of all transbay BART trips were between San Francisco and the 6 stations of the Concord Line; 21% to the 8 Fremont Line stations; 17% to the 5 Oakland stations; and the remaining 18% to the 6 Richmond Line stations.

Transbay Traveler Profiles

Reflecting the predominant pattern of commuting to and from downtown San Francisco work places from the middle and upper income suburbs of the East Bay, transbay BART travelers were mainly male (69%), white (89%), and had above average incomes. Twenty-five percent of transbay BART travelers reported gross family incomes of $25,000 or more. Thirty-five percent had attended more than four years of college.

This shows a profile of socioeconomic status significantly higher than for the Bay Area as a whole. However, it is very close to the population profile of all transbay travelers, most of whom travel by automobile. The proportion of racial minority and low-income travelers using BART was noticeably lower than for bus: 11% of transbay BART trips were made by nonwhite travelers compared to 20% of bus trips; 20% of BART trips were made by travelers with family incomes less than $10,000 compared to 25% of bus trips. Thus, for the predominant direction of travel from homes in the East Bay to work places in San Francisco, BART served a slightly higher proportion of white and high income travelers than the average for transbay travel by all modes. However, in the reverse commute direction, BART ridership was made up of appreciably more low-income and racial minority travelers than was the case for transbay travel as a whole.

Travel Times and Costs for Transbay Travel

Reflecting the predominance of commuter travel across the Bay from the more distant suburbs, travel times for transbay trips made on BART were significantly longer on the average (58 minutes) than either bus trips (48 minutes) or automobile trips (35 minutes). With an average total one-way trip cost of $1.35, BART trips were significantly more expensive than bus trips ($0.90) but much less costly than automobile trips as travelers perceived them ($3.05).

For those transbay BART travelers who previously rode the bus, the average trip by BART took slightly less time (58 minutes compared to 62 minutes), but was slightly more expensive ($1.30 compared to $1.25). Thus a small time-for-money trade-off was being made. For those transbay BART travelers who switched from automobile, BART was substantially slower for the door-to-door journey (57 minutes compared to 44 minutes) but was perceived by travelers as being much less costly ($1.50 compared to $3.00). Thus, in contrast to those travelers diverted from bus, previous automobile travelers made a money-for-time trade-off in taking BART.

Access to BART

The availability of access to and from BART stations was a dominant factor in travelers' decisions to use the System. In San Francisco, most (77%) of all transbay trip-makers walk to and from BART. For trips between work and home, the percentage was even higher (84%). In the East Bay, automobile was the main access mode for transbay BART trips, being used by 62% of all trips. Bus was used as the access mode for 16% of the trips. However, these figures conceal the very large variations among different stations. The percentage of transbay trips using automobile varied from over 90% at the remote sub-urban stations on the Concord and Fremont Lines, where very limited feeder bus service was available, to under 10% in downtown Oakland and Berkeley.

Particularly in the East Bay, the availability of access to BART stations was a significant constraint on the use of BART. A large number of travelers who continued to drive across the Bay Bridge felt that they could walk to their destination at the San Francisco end of the trip. These made up about 39,000 trips in total. This number implies a considerable market segment of potential BART riders which was, as then, untapped--in part because of the difficulties of access at the East Bay end of the trip. These difficulties are reflected in part, by the fact that, at many BART stations, existing automobile parking space was utilized to capacity. For example, the five stations on the Concord Line in Contra Costa County had parking space for 5,400 vehicles, virtually all of which was taken by 9:00 a.m., and generally much earlier. Similarly, the five southernmost stations on the Fremont Line, with a combined parking capacity of 3,800 spaces, were essentially full by 9:00 a.m. On both lines, these stations also had the poorest feeder bus service. These parking constraints were, and still are, a particular obstacle to improving off-peak ridership on BART--on which many hopes for the System's ultimate success depend.

Interim BART Service Levels

At this interim stage of operations, BART's transbay ridership is also severely constrained by the passenger-carrying capacity of its currently available cars. Not all of its projected fleet have, as yet, been delivered. In addition, mechanical reliability and maintenance problems meant that, at the time of the surveys, only about 200 cars were available for revenue service compared

to the currently planned full-operations availability of about 400 cars. This shortage of cars gives rise to crowding levels that are significantly higher than those ultimately anticipated, and causes considerably higher peak period levels than many travelers find acceptable, especially for the typically long transbay journeys. Over the two-hour morning peak period, load factors on Concord Line trains typically average between 1.5 and 2.0 times the number of seats. Occasional trains approach load factors of 3.0 (i.e., twice as many standing passengers as seated).

Various operating reliability problems are further evidence of the interim nature of the current BART System. These problems result both from the current high rate of mechanical failure of trains and the limitations of the interim train control system.

A further limitation on current BART service is that the System provides direct service from Daly City to Concord and Daly City to Fremont but not Daly City to Richmond, as planned for the future. A transfer is therefore required for transbay passengers traveling to or from the Richmond Line. At this stage in BART's operations, trains of up to a 650-seat capacity are being run to a combined scheduled headway of 6 minutes beneath the Bay, compared to the 2-minute headways planned for full-system operation. Service over the whole BART System is also only provided from 6:00 a.m. to 8:00 p.m. from Monday to Friday, compared to the full 20-hour-a-day, 7-day-a-week schedule ultimately planned.

BART Traveler Attitudes

The current System's shortcomings are clearly manifested in the attitudes of travelers toward the System. All transbay travelers--both those who ride BART, and those who do not--rated seat availability and dependability as the BART characteristics that they were least satisfied with relative to the alternative modes. In contrast, all transbay travelers perceived BART favorably in terms of its comfort, safety from accidents, and security from crime. The cost of BART was also perceived very favorably by current automobile travelers or those riding BART who previously used automobile for the transbay trip.

These attitudes suggest that as BART resolves its current problems of seat availability and dependability and approaches planned full-system operation, many transbay travelers currently using automobile or bus may switch to BART. However, full realization of BART's passenger-carrying potential ultimately depends on the provision of improved access to the System by automobile and bus.

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I. INTRODUCTION

The Transbay Travel Corridor

In 1970, the cities in the three counties of Marin, San Francisco, and San Mateo on the western side of San Francisco Bay had a combined population of 1,480,000 people and an urbanized area of 160 square miles. Employment in the three counties was 780,000, of which 500,000 jobs were in the City of San Francisco itself. To the east of San Francisco Bay, Oakland and the other cities in Alameda and Contra Costa Counties had a total population of 1,630,000 and an urbanized area of 270 square miles. Employment was 610,000.*

Oakland and the other "East Bay" cities are linked to Marin County and the San Francisco Peninsula by three major highway toll bridges: the Richmond-San Rafael Bridge, the San Francisco-Oakland Bay Bridge, and the San Mateo-Hayward Bridge. The locations of these are shown on the map of Figure I-1. By far the most important of these bridges is San Francisco-Oakland Bay Bridge (generally referred to as the Bay Bridge) which connects the freeways of the San Francisco Peninsula and the employment centers of San Francisco directly to Oakland and the major freeways leading to the industrial and residential areas of the East Bay. Typically, in excess of 90,000 vehicles a day travel on the 5 lanes of the San Francisco-Oakland Bay Bridge in each direction. The San Mateo-Hayward Bridge carries about 15,000 vehicles in each direction and the Richmond-San Rafael Bridge about 10,000.

Bus has also been an important mode of transport in the congested San Francisco-Oakland Bay Bridge corridor, especially for journeys from the East Bay cities to work in San Francisco. In early 1974, over 30,000 trips per day were made by bus across the Bay Bridge in each direction. Most of these trips were made on the transbay bus routes of the Alameda-Contra Costa Transit District (AC Transit) to the Transbay Bus Terminal in downtown San Francisco. Greyhound Lines have also provided transbay commuter bus services from Concord and other eastern areas of Contra Costa County.

Transbay BART Service

On September 16, 1974, the Bay Area Rapid Transit (BART) System started service through the "Transbay Tube" beneath San Francisco Bay, thereby adding substantial transportation capacity in this very heavily traveled corridor.

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*Population, Employment, and Land Use Alternatives in the San Francisco Bay Region: 1970-2000, Series 2 Projections. Technical Report of the Joint Planning Program of the Association of Bay Area Governments (ABAG) and Metropolitan Transportation Commission (MTC), September 1974.

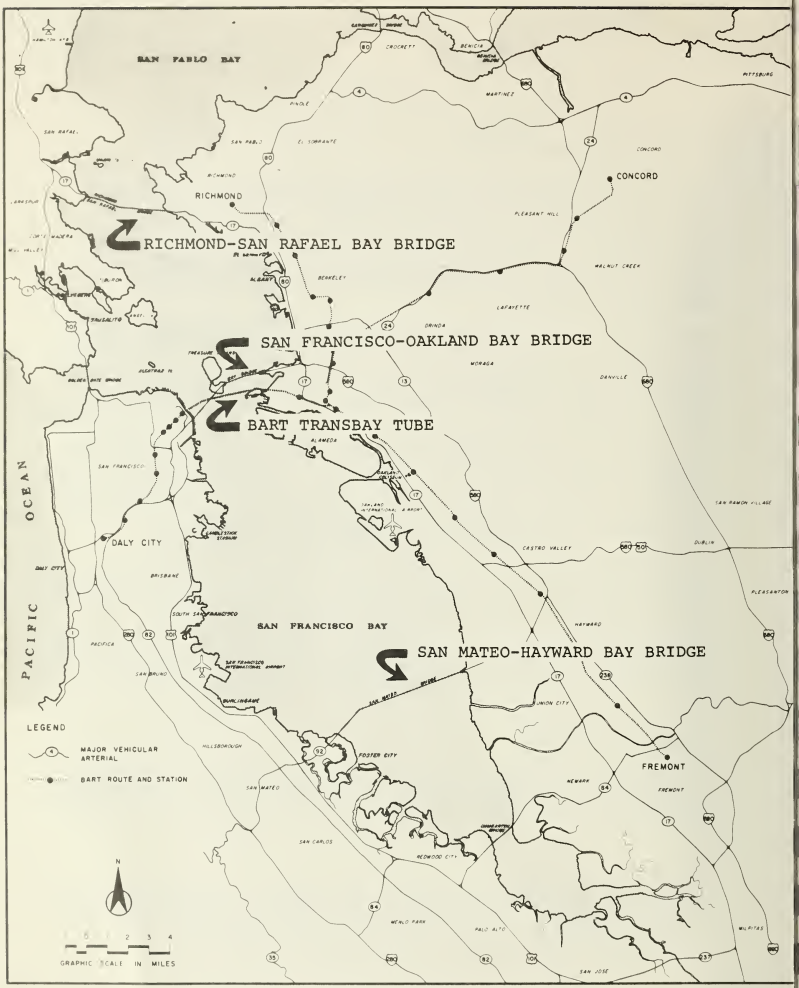

FIGURE I-1

TRANSBAY TRAVEL ROUTES

Two of the three planned transbay BART lines started operation at this time: the one running trains directly between Daly City and Concord (the Concord Line) and the other directly between Daly City and Fremont (the Fremont Line).* Trains on the two transbay lines run to a combined scheduled headway of 6 minutes, with Concord Line and Fremont Line trains each running at approximately 12-minute headways. Trains vary in length according to the time of day, with a maximum train length of 9 cars (and a corresponding capacity of about 650 seated passengers plus well over 1,000 standees).

The start of service through the 4-mile long Transbay Tube added the final and most important rail link to the BART System, connecting the 8 route-miles of line in San Francisco, with its 3 current downtown stations, to downtown Oakland and the 59 route-miles of the BART System on the East Bay.**

As shown in Figure I-2, the addition of the transbay link to the BART System has given rise to a very large increase in total System ridership. Before the start of transbay service, BART ridership averaged about 70,000 one-way trips per day on the San Francisco and East Bay lines. Including the transbay link, System ridership had climbed to over 120,000 trips per day by December 1974.*** Transbay ridership thus accounts for about 44% of total BART System ridership.

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*Passengers traveling from Daly City and San Francisco to stations on the Richmond Line are required to transfer in Oakland to trains running on the third line of the current BART System between Fremont and Richmond.

**The San Francisco Line from Daly City is made up of 8 route-miles of track and contains 8 stations. The final BART station of the currently planned BART System, the Embarcadero Station in downtown San Francisco, is not yet open. The Transbay Tube is 4 miles long. The central Oakland section of the System contains 5 stations and 7 route-miles. The Concord Line, including its tunnel through the Berkeley Hills, is made up of 18 route-miles and contains 6 stations serving the rapidly growing residential communities of Orinda, Lafayette, Walnut Creek, and Concord in eastern Contra Costa County. The Fremont Line is made up of 24 route-miles of track and contains 8 stations in the southern Alameda County Cities of southern Oakland, San Leandro, Hayward, Union City, and Fremont. The Richmond Line contains 16 route-miles and 6 stations in the Cities of Berkeley, El Cerrito, and Richmond.

***No particular significance should be attached to the upward trend in System ridership over the period September to December 1974. In part, this reflects the fact that BART operated until 10:00 p.m. during the Christmas shopping period (November 29 to December 27, 1974). The upward trend has not been sustained in the months since then. Average ridership in January, February, and March 1975 was, respectively, 118,000, 114,000, and 116,000 trips per day.

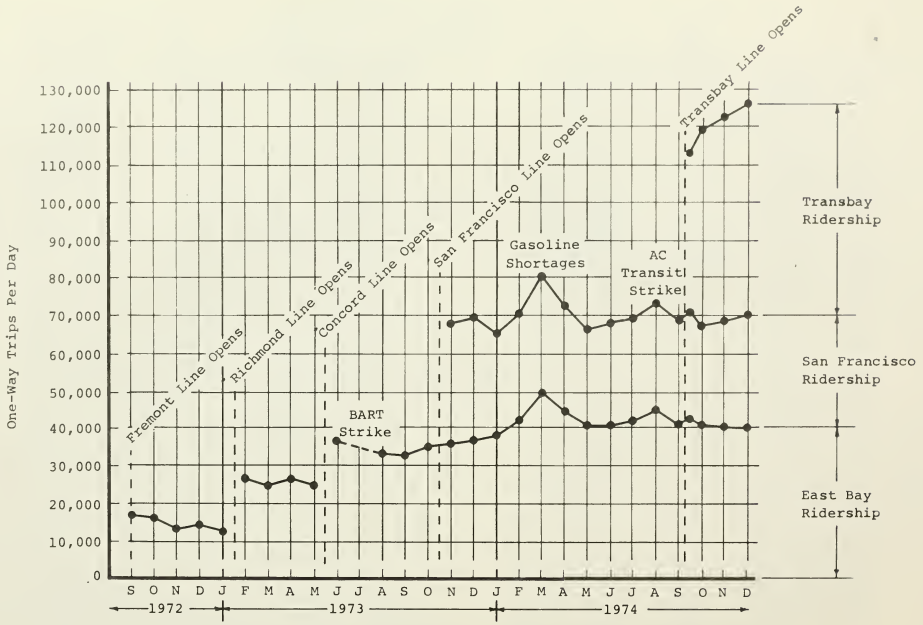

FIGURE I-2

AVERAGE DAILY BART RIDERSHIP, SEPTEMBER 1972 - DECEMBER 1974

Source: • BARTD Office of Research, BART Monthly Patronage Reports

Hypothesized Impacts of Transbay BART

Many hypotheses have been advanced regarding the impacts of BART on transportation and land use patterns; the environment; the economy; and, in general, the lives of people in the Bay Area. These have been reviewed at length elsewhere.*

Most of these can be considered to arise, either directly or indirectly, from BART's impacts on the transportation system and travel behavior. These impacts of BART have also been hypothesized in detail elsewhere,** and can be considered to arise within the following framework: BART changes the level of service provided by the transportation system, and this gives rise to changes in the "impedances" of travel as perceived by travelers (i.e., the various components of travel time, cost, comfort, and convenience which determine travel choice). The changes in these travel impedances affect individual choice decisions and behavior, which result in changes in the aggregate patterns of travel on the transit and highway facilities of the transportation system.

Nearly all of the travel impacts which have been predicted or hypothesized for the BART System as a whole apply, to a greater or lesser extent, to the transbay corridor. In summary, it has been hypothesized that transbay BART service provides an alternative to taking the bus or driving across the San Francisco-Oakland Bay Bridge which is significantly more attractive to many travelers in terms of the perceived impedances of travel. The resulting ridership on BART changes the pattern of transbay travel with regard to both the total volume of trips made, and the modal split between transit and the automobile. To the extent that diversions to BART are from private automobile, depending on the time of day, there is a reduction in peak period highway traffic congestion on the Bay Bridge. This, in turn, may lead to secondary impacts such as changes in the number of transbay automobile trips made, changes in the time of day of travel, and diversion of highway traffic to the San Francisco-Oakland Bay Bridge from the other transbay routes, particularly the San Mateo-Hayward Bridge.

This series of hypotheses gives rise to the questions of what are the kinds and magnitudes of BART's impacts on travel patterns. A description of travel on transbay BART and the automobile and bus alternatives in terms of the

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*See, for example, "A Description of the BART Impact Program," Metropolitan Transportation Commission, Berkeley, California, March 1974; and "A Review of Some Anticipated and Observed Impacts of the BART System," BART Impact Program Document Number PD 3-1-74 prepared by Peat, Marwick, Mitchell & Co., Burlingame, California, for the Metropolitan Transportation Commission, Berkeley, California, May 1974.

**"Transportation System and Travel Behavior Project Research Plan," BART Impact Program Document Number PD 14-3-75, prepared by Peat, Marwick, Mitchell & Co., Burlingame, California, for the Metropolitan Transportation Commission, Berkeley, California, May 1975.

purposes of travel, trip origin and destination patterns, and methods of access to and from BART are also necessary to answer these what questions. The profile of socioeconomic characteristics of BART's riders relative to automobile and bus riders--the question of who rides (and who does not ride) BART--is also of great importance in assessing the incidence of BART's impacts. Finally the question of why transbay travelers are, or are not using BART is of concern.

Scope of the Report

The objective of this report is to measure and, as far as possible, to explain the impacts of BART on the transportation system and travel behavior in the period immediately after the start of transbay service in terms of the above three questions: What have been the impacts of transbay BART? Who has been affected? Why have these impacts occurred?

Chapter II summarizes the surveys, data bases, and analysis methods on which the findings of the report are based.

Chapter III addresses the question of what changes have taken place in aggregate transbay travel over the period before and after the start of transbay BART service. Changes in travel by private automobile, bus, and BART are analyzed over both the short term and the longer term as a means of assessing what changes in the travel patterns may reasonably be attributed to BART.

Chapter IV analyzes the changes in peak period highway traffic congestion on the San Francisco-Oakland Bay Bridge and its approaches that have accompanied the start of BART service. The chapter includes analyses of changes in the hour-by-hour distribution of Bay Bridge traffic and changes in peak period highway travel times on the bridge and its approaches.

Chapter V concludes the assessment of the what questions by describing the journeys being made by BART, bus, and private automobile between San Francisco and the East Bay. Transbay journeys are analyzed in terms of purpose; time-of-day of travel; origin-destination patterns; and, in the case of BART journeys, modes used for access to and from the System.

Chapter VI addresses the who questions by presenting socioeconomic profiles of transbay travelers. Firstly, BART traveler profiles are compared to those of bus and automobile travelers. Secondly, the characteristics of BART travelers are compared according to their previous mode of travel. Thirdly, the characteristics of transbay BART travelers are compared to those traveling on BART lines within the East Bay or in San Francisco. In making these comparisons, emphasis is given to the usage of transbay BART and the alternatives by low-income and racial minority travelers.

As a means of addressing the questions of why travel behavior has changed as a consequence of BART, Chapter VII concludes the "findings" chapters of the report by summarizing the travel impedances of BART and the alternative transbay modes as they are perceived by travelers. Also analyzed are travelers'

attitudes toward these impedances, in terms of both the importance they attach to different impedance factors, and their satisfaction with BART and the alternative transbay modes.

Finally Chapter VIII presents the conclusions of this assessment of transbay BART's immediate impacts.

Interim Nature of Impacts

The interim nature of the assessment presented in this report needs to be emphasized. The surveys of transbay travel were conducted only about six weeks after the start of transbay BART service. While the analyses indicate that by this time transbay travel patterns were reasonably stable from day to day, inevitably, the surveys reveal transitional travel patterns to some degree. This is especially true to the extent that some travelers were still trying BART for the first time.

It must also be emphasized that travelers' perceptions of the travel impedances of BART, and hence their travel behavior, are based on a level of BART service that is considerably lower than the level planned for full service. Under the interim CABS-1 control system* in use at the time of the surveys, trains were operating through the Transbay Tube at headways of 6 minutes rather than the 2 minutes planned for full-system operation. Also, only 2 of the 3 planned transbay lines (from Daly City to Concord and to Fremont) were in operation, requiring transbay travelers to stations on the Richmond Line to transfer in Oakland. BART car availability was also below that anticipated for full service. Only about 200 cars were available for revenue service (operated as 30 trains with up to a maximum of 9 cars per train) compared to the planned full-operations availability of over 400 cars. This shortage of cars gives rise to crowding levels that are significantly higher than those ultimately anticipated. Operating reliability problems also significantly affected the level of service. These result from both the high rate of mechanical failure of trains and the limited capability of the interim CABS-1 backup to the automatic train control system to recover from schedule disruptions. Finally, BART was and is currently operating only over the 14 hours from 6 a.m. to 8 p.m. during weekdays, compared to the ultimately planned 20-hour-a-day, 7-day-a-week schedule of operations.

As a result of these constraints, the level of service offered by BART is much below that planned for full-service operations. Thus, the findings presented in this report, while valid for the interim level of BART service provided at the time, do not necesssarily give a picture of attitudes and behavior that will apply when BART is in full operation as originally planned.

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*CABS-1: Computer Automated Block System, with one station spacing. This is the backup to the automatic train control system (ATC) which the California Public Utilities Commission required to be developed before allowing transbay operations.

Other Concurrent Changes Affecting Transbay Travel

Finally, it must be emphasized that the introduction of transbay BART service is only one of a number of influences which can be expected to have changed transbay travel behavior. Prior to the start of transbay BART, there was a serious gasoline shortage in early 1974 and, asscciated with it, a 50% increase in gasoline prices. On January 1, 1974, a 55 mph speed limit was imposed on all highways. In March 1974, a system of computer-operated traffic signals went into operation on the westbound approach to the Bay Bridge as a means of metering traffic volumes and so reducing congestion. During the months of July and August 1974, there was a strike of AC Transit employees which eliminated most transbay bus service and significantly distorted travel patterns over the Bay Bridge.

In addition to all these specifically transportation system-related events, the previous year saw other significant underlying economic changes. Apart from growth in the population of the area, price levels increased significantly, as did unemployment rates--evidencing a significant recession in the economy of the Bay Area and the nation as a whole. The changes in travel patterns that are discussed in the succeeding chapters of this report must be viewed in the context of all these influences.

II. SURVEY AND DATA COLLECTION METHODOLOGY

Sources of Information

In order to address the questions raised in the previous chapter, the Transportation System and Travel Behavior (TSTB) Project undertook a coordinated program of surveys, data collection, and analysis. The objective of this program was to assemble a comprehensive picture of passenger travel by BART, bus, and private automobile across the San Francisco-Oakland Bay Bridge screenline before and after the start of transbay BART service. The survey and data collection program involved the assembly of three principal data sets. These were obtained by:

- Counts of highway vehicle traffic and transit ridership on bus and BART.
- Highway travel time surveys.
- On-route questionnaire surveys of the population of transbay trips made by BART, bus, and private automobile; and associated control surveys.

Detailed descriptions of the methodologies used in assembly of the data sets are given in a separate report of the TSTB Project.* In this chapter, only a summary description of each is given.

Counts of Transbay Vehicle and Passenger Volumes

The analyses of aggregate transbay travel patterns were based on data collected from several sources. The most important of these are given below.

California Department of Transportation (CALTRANS), Toll Bridge Administration, Traffic Volume Counts. Volume counts are maintained by CALTRANS on a continuing basis for westbound vehicle traffic crossing the San Francisco-Oakland Bay Bridge, the San Mateo-Hayward Bridge, and the Richmond-San Rafael Bridge. These "totalizer counts" are counts of vehicles (not classified by type) for each lane of the toll plaza by time period (normally hourly, but sometimes at more frequent intervals). Strictly, the counts are for toll transactions, rather than vehicles; for the special priority bus lane on the Bay Bridge where vehicles do not stop to pay a toll, mechanical (axle) counts

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*"Surveys of Transbay Travel, October 1974," BART Impact Program Document Number DD 4-3-75, prepared by Peat, Marwick, Mitchell & Co., Burlingame, California, for the Metropolitan Transportation Commission, Berkeley, California, May 1974.

are recorded. The totalizer volume counts are routinely summarized by the Toll Bridge Administration on a daily basis. Summary distributions of traffic on an hourly basis are also prepared by the Toll Bridge Administration from time to time. In addition to these summaries, the TSTB Project abstracted further detailed volume data from the original totalizer printout records.

CALTRANS Traffic Volume Counts on San Francisco-Oakland Bay Bridge Approaches. The traffic counts on the Bay Bridge itself were supplemented by a set of traffic counts conducted by CALTRANS especially for the BART Impact Program. Counts of westbound vehicle traffic volumes on the three freeway approaches to the bridge were recorded by mechanical counter and summarized by 15-minute intervals for a 10-day period beginning on September 12, 1974.

BART Ridership Counts. Counts of passengers entering and exiting the automatic faregates at all BART stations are recorded on a continuing basis by the Bay Area Rapid Transit District (BARTD). Individual faregate counts are recorded daily, and on Wednesdays, by five periods during the day. However, counts of ridership on the links of the System--specifically transbay ridership--are not available on a day-by-day basis.* The estimates of transbay ridership summarized in BARTD's monthly patronage reports and quoted in these analyses are based on transbay BART ridership counts taken by the Institute of Traffic and Transportation Engineering (ITTE) on one day in October 1974 (see below). Estimates of transbay ridership for subsequent months have been estimated by BARTD on the basis of the ITTE transbay counts and total system patronage as recorded by the faregate counts, assuming a constant proportional relationship between transbay and total System ridership. These estimates may be inaccurate to the extent that the proportion of transbay ridership in the total has changed from the time of the October ITTE surveys.

Bus Ridership Counts. Day-by-day, AC Transit records estimates of passengers carried on all their bus routes including transbay routes. On transbay routes these summaries include passengers on transbay buses who are traveling entirely within the East Bay. Therefore, the summaries overstate actual transbay patronage.

Greyhound Lines makes periodic counts of ridership on its Contra Costa County commute services from Concord, Walnut Creek, Danville, and Lafayette. The counts do not comply with any regular schedule, but are recorded and submitted to the California Public Utilities Commission (PUC) as required.

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*At the time of the surveys and analyses reported here, BART's automatic data acquisition system (ADAS), which will eventually allow monitoring and recording of ridership for all origin-destination station-pairs and on all links of the System by time of day, was not fully operational.

ITTE Bay Bridge Travel Surveys. Based on the above data sources as well as their own surveys, ITTE has for many years compiled summaries of traffic across the San Francisco-Oakland Bay Bridge on typical weekdays in April and October. Traffic volumes are summarized for both westbound and eastbound vehicle volumes over the 24-hour day. For the 12-hour period, 6:30 a.m. to 6:30 p.m., vehicle volume counts are classified by vehicle type; automobile occupancy and bus occupancy counts are also recorded. Passenger volumes on AC Transit and Greyhound buses (and, in October 1974, on BART) are also recorded in both directions of travel, distributed over the day. As mentioned above, the one-day count of transbay BART ridership conducted by ITTE is the only available full sample count of ridership available at this time.

Highway Travel Time Survey

A series of highway travel time runs were undertaken by CALTRANS personnel in September and October 1974 following the start of transbay BART service. These surveys were conducted by the "moving car observer" method in which the driver of the survey vehicle adjusts his speed to the norm of the vehicles around him. Travel times were recorded on tachographs. These are devices which, when actuated, simultaneously record elapsed time and distance from the survey starting point.

Data were observed only on Tuesdays, Wednesdays, and Thursdays during the morning (6:00 a.m. to 9:00 a.m.) and evening (3:00 p.m. to 6:00 p.m.) peak periods. Descriptions of the routes surveyed are given in Chapter IV.

BART Impact Program October 1974 Surveys of Transbay Travel

The transbay travel surveys undertaken by the TSTB Project of the BART Impact Program in October 1974 were designed to provide a random sample of the population of transbay trips which are, or might be made by BART. To this end, three on-route surveys were undertaken:

- A questionnaire handout survey of a sample of BART travelers entering San Francisco BART stations.
- A questionnaire handout survey of a sample of transbay bus travelers boarding buses at the downtown San Francisco Transbay Bus Terminal.
- A questionnaire handout survey of a sample of automobile drivers and passengers passing through the toll booths on the San Francisco-Oakland Bay Bridge.

The three populations sampled in these surveys include the overwhelming majority of transbay trips. However, it should be noted that peak period trips made by car pool through the priority lanes of the Bay Bridge (about

2,000 vehicles a day) were excluded.* Trips made by bus to destinations on the West Bay other than the Transbay Bus Terminal were also excluded. These are a relatively small number of trips made by long distance (Greyhound and Continental Trailways) buses and other chartered buses. Finally, trips made by the drivers and passengers of trucks and other commercial vehicles were not included in the survey samples.

In addition to the three on-route surveys, two other surveys were conducted as validation mechanisms:

- A telephone survey of households in cities on the East Bay
- An observational census of travelers entering selected BART stations

Transbay BART Survey. A total of 19,000 questionnaires were distributed to travelers over 12 years of age entering the 8 San Francisco BART stations during the full day of BART operations (6:00 a.m. to 8:00 p.m.) on Wednesday, October 30, 1974. The questionnaire was an 8-1/2 inch by 5-1/2 inch, 8-page booklet.

The questionnaire requested information about the purpose, origin, destination, access modes, travel time, and cost of the BART journey being made; how the journey was made prior to the start of BART service; attitudes toward BART and the previous mode of travel; and demographic information about the traveler and his household.

Passengers were asked to fill out the questionnaire while traveling or at their destination and return it by mail. The back cover of the questionnaire had a prepaid postage stamp and a return address. Pencils were handed out to passengers to allow them to fill in their questionnaires while traveling.

All questionnaires were serial numbered and distributed according to a carefully predetermined schedule which ensured that questionnaires were distributed approximately in proportion to the numbers of travelers entering the stations at different times of the day. The actual number handed out in each of six periods during the day was recorded in coordination with readings of the faregate counters. This allowed a precise control to be maintained on the location and time of handout of any given questionnaire. A total of 28 survey staff members were employed in the questionnaire handout over the day.

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*At the time of the Bay Bridge survey, during the peak periods 6:00 a.m. to 9:00 a.m. and 3:00 p.m. to 6:00 p.m., two lanes through the toll plaza were reserved for automobiles carrying three or more persons. Car poolers who were holders of special passes (about two-thirds of the total) were not required to stop at the toll booths. Car poolers without the special pass were required to stop and pay the normal 50¢ toll (but nevertheless benefited from the shorter waiting time at the toll plaza).

In the month following the survey, about 7,600 or 40% of all distributed questionnaires were returned. Of these, about 2,900 were transbay travelers (eastbound) and the remainder were people traveling within San Francisco. Of the 2,900 transbay questionnaires returned, 2,000 were randomly selected for coding and analysis. Given the total eastbound transbay ridership of 26,100, these questionnaires, overall, represent a 1 in 13 or 8% sample of the population of transbay BART trips.

The number of coded questionnaires was recorded for each time period and for each handout station. Comparison of the number of questionnaires coded with the number of passengers recorded by the entry faregates allowed a separate sampling rate to be computed for each time period and each station. These differential sampling rates were used as weighting factors in analysis of the data set, thereby accounting for those nonresponse errors caused by differential response rates by time of day and location.

Transbay Bus Survey. Transbay trips by AC Transit and Greyhound commuter bus routes were surveyed by handing out questionnaires to a random sample of travelers boarding buses at the Transbay Bus Terminal in San Francisco. A total of 5,800 questionnaires was distributed from 7:00 a.m. to 7:00 p.m. on Wednesday, October 30, 1974, the same day as the BART survey.

The questionnaire was similar in format to that used for the BART survey, but requested information about how the trip could be made by BART rather than about a previous mode of travel. The questionnaires were serial numbered and distributed according to a prespecified handout schedule by hour or half-hour time periods to ensure a uniform handout rate over the day. Pencils were distributed to assist respondents. A survey staff of seven was employed to distribute the questionnaires.

Overall, 38% of those handed out were returned by mail, and 2,000 of the 2,200 questionnaires returned were randomly selected for coding. These 2,000 represent a 1 in 9 sample (12%) of all transbay bus trips. Passenger counts summarized by 15 time periods over the day were used to compute sampling rates for the different time periods. These, in turn, were used as weighting factors to account for differential time-of-day nonresponse errors.

Survey of Transbay Automobile Drivers and Passengers. Questionnaires were handed to the occupants (both drivers and passengers) of westbound private automobiles as they stopped at the toll booths on the San Francisco-Oakland Bay Bridge. The survey was conducted during the daylight hours on Wednesday, October 30, 1974. During this time, 16,200 questionnaires, similar in format to those used in the bus survey, were distributed according to a schedule which ensured a uniform questionnaire handout rate for all lanes and for all hours of the day. Lane 10, which is used exclusively by buses, was not surveyed. Lanes 8 and 9 were not surveyed during the peak periods (before 9:00 a.m. and after 3:00 p.m.), since they were used as priority car pool lanes during these periods. A survey staff of 12 people was used to hand out the questionnaires.

Of those distributed, 3,100 or 19% were returned by mail. A sample of 2,000 was randomly selected for coding and analysis, representing a net sampling rate of 1 in 46 or 2% of the total population of transbay private automobile trips. Vehicle traffic counts recorded by lane and by time period were abstracted from the Toll Bridge Administration's "totalizer count" for the day. These control totals allowed differential sampling rates by lane and by time of day to be computed and used as weighting factors in the analysis.

Telephone Survey of East Bay Households. The on-route surveys of transbay BART, bus, and automobile trips described in the previous sections were carefully conducted to avoid sampling errors (i.e., errors arising because not all trips in the population were sampled). However, the fact that between 60% and 80% of those who received questionnaires did not return them gives rise to the possibility of nonresponse errors (i.e., errors arising because information was not obtained for all trips in the sample). This is a generic problem of all mail-back surveys. Appreciably higher response rates are generally obtained from telephone surveys. Accordingly, as a means of measuring and, if necessary, compensating for potential nonresponse bias in the mail-back surveys, a telephone survey of households in the East Bay Counties of Alameda and Contra Costa was conducted.

The telephone survey was conducted on weekdays over a three-week period around the time of the on-route surveys. A random sample of telephone numbers was drawn from the total of 455,000 residential telephones listed in the five telephone directories covering the area. An interviewing procedure was followed which screened households contacted according to whether or not a transbay trip had been made by any member of the household on the previous day. Only 1 in 3 households from which no transbay trips were made were interviewed, while all households from which a transbay trip had been made were interviewed. In this way, approximately equal samples of transbay and nontransbay traveling households (305 and 380, respectively) were interviewed.

For transbay trip-making households, the age and sex of each household member who made a transbay trip was recorded; and for each trip, the purpose, mode of travel, and return mode of travel were recorded. For nontransbay trip-making households, the age and sex of all members was recorded. In addition, all respondents were asked to give household automobile availability, whether or not a member of the household was physically handicapped, their race, and family income.

Results of the survey were weighted on two bases: firstly, to represent the ratio of transbay to nontransbay trip-making households identified in the screening interviews; and secondly, to represent the proper distribution of households among the areas covered by the telephone directories. The resulting weighted data form a valid basis for comparison with the on-route survey results.*

*A comparative evaluation of the results of the on-route and telephone surveys is given in Appendix A.

Observational Census of BART Travelers. As a further basis for estimating and controlling nonresponse error in the survey returns, and as a verification of the faregate counts, a detailed classified count was taken of passengers entering three San Francisco BART stations (Montgomery Street, 24th Street-Mission, and Daly City). The census was taken over the same period (6:00 a.m. to 8:00 p.m.) as questionnaires were handed out at the same stations on Wednesday, October 30, 1974. The counts were also coordinated with the times at which faregate readings were taken.

Passengers over 12 years of age entering these stations were classified by sex, age (under 25, 25 to 44, 45 or over), and ethnic identity (white, black, or other). Continuous 15-minute counts were taken at 30-minute intervals throughout the day. Census takers positioned themselves so that they were able to see all passengers entering the station. At times when the flow of passengers was too great to allow a 100% sample, census takers were given instructions which allowed a random sample of traveler characteristics to be recorded. In these instances, an estimate was made of the proportion of travelers who were included in the sample.

In addition to classifying passengers by sex, age, and race, the census takers made a note of all physically handicapped people entering the station during counting periods. These were categorized by blind people, people in wheelchairs, and people using crutches or canes to walk.*

*Results of the census and on-route surveys of BART are compared in Appendix A.

III. AGGREGATE TRANSBAY TRAVEL PATTERNS

Short-Term Changes in Highway Traffic Volumes on the Bay Bridge

Comparison of the weeks immediately before and after the start of transbay BART service on September 16, 1974, shows a marked reduction in traffic on the San Francisco-Oakland Bay Bridge. This is shown in Figure III-1. Average midweek traffic during the week of September 9 was a daily total of 94,100 vehicles traveling westbound across the Bridge, of which 81,400 occurred during the 14 hours between 6:00 a.m. and 8:00 p.m. (the hours of BART operation). During the week of September 16, the corresponding figures were 88,700 vehicles over the whole day, and 76,300 in the period 6:00 a.m. to 8:00 p.m. The reduction in total daily traffic between the two weeks is thus 5,400 vehicles or 6%. Nearly all of this reduction (5,100 vehicles) occurred during the 14 hours of BART operation.

Changes in the Distribution of Bay Bridge Traffic Over the Day. The pattern of changes in Bay Bridge traffic over the day is illustrated in Figure III-2, which compares the hour-by-hour distribution of traffic for typical midweek days immediately before and after the start of transbay BART service (Thursday, September 12, and Thursday, September 19, 1974).

Comparison of the two sets of points shown in Figure III-2 shows no perceptible differences outside the 14-hour day of BART operation. During all other hours of the day, the "after BART" distribution was consistently lower than the "before BART" distribution. There was an obvious reduction in traffic at the peak hour 7:00 a.m. to 8:00 a.m. (a reduction of 400 vehicles, or 4%), but even more marked were the reductions in the hours on either side of (and particularly following) the morning peak hour. The difference between the two distributions for the hour 6:00 a.m. to 7:00 a.m. was 600 vehicles (9%); for the hour 8:00 a.m. to 9:00 a.m., 900 vehicles (11%); for the hour 9:00 a.m. to 10:00 a.m., 500 vehicles (8%); and for the hour 10:00 a.m. to 11:00 a.m., 500 vehicles (9%). Similar differences are revealed by comparison of traffic distributions on other days in the periods immediately before and after the start of transbay BART.

Although it is not possible to be certain about the causes of these changes, it seems clear that Figure III-2 illustrates a substantial diversion of automobile travel to BART and that this diversion occurred mainly over the morning peak period. It is possible that the marked reduction in traffic later in the morning can be explained by the fact that travelers who previously drove later than they would have liked were able to travel at an earlier and more convenient time because of reduced congestion. Overall midweek morning peak period (6:00 a.m. to 9:00 a.m.) traffic decreased from 23,900 vehicles to 22,200 vehicles between the weeks of September 9 and September 16, 1974, a reduction of 1,700 vehicles (7%).

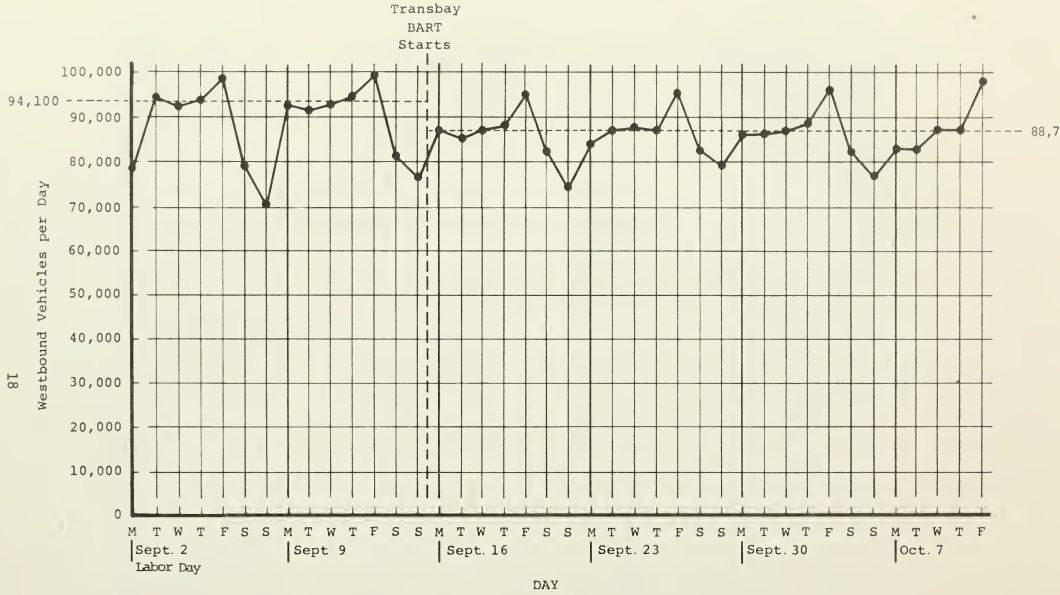

FIGURE III-1

SAN FRANCISCO-OAKLAND BAY BRIDGE DAILY WESTBOUND VEHICLE TRAFFIC
DAY-BY-DAY TRAFFIC LEVELS, SEPTEMBER 2 - OCTOBER 11, 1974

Source: • CALTRANS Toll Bridge Administration, Daily Totalizer Volume Counts.

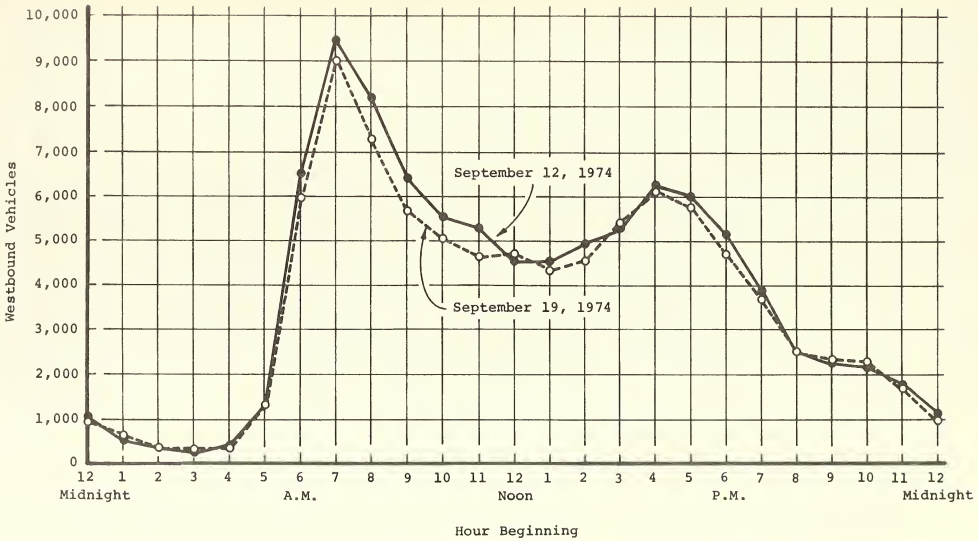

FIGURE III-2

SAN FRANCISCO-OAKLAND BAY BRIDGE WESTBOUND VEHICLE TRAFFIC DISTRIBUTION OVER THE DAY
THURSDAYS IMMEDIATELY BEFORE (SEPT 12) AND AFTER (SEPT 19, 1974) START OF TRANSBAY BART SERVICE

Source: • CALTRANS Toll Bridge Administration, Hourly Distribution of Traffic

Changes in Highway Traffic on the Approaches to the Bay Bridge. As shown in Figure III-3, there are three major freeways leading to the San Francisco-Oakland Bay Bridge on the East Bay. These are Interstate Route 80 (East Shore Freeway) from the north; Interstate Route 580 (MacArthur Freeway) from the south (which also carries Route 24 [Grove-Shafter Freeway] traffic from the east); and Route 17 (Nimitz Freeway) from the south. These three freeways merge in a major interchange just before the Bay Bridge toll plaza. Only one other road (West Grand Avenue) merges into the toll plaza lanes beyond this interchange.

The distribution of westbound midweek traffic on the Bay Bridge from these approaches before the start of the transbay BART service was about 34% from Route 80, 41% from Route 580 (including Route 24 traffic), 24% from Route 17, and 1% from West Grand Avenue. Over the peak period 6:00 a.m. to 9:00 a.m., a greater proportion of traffic approached from Route 580/24, the distribution being about 31% from Route 80, 48% from Route 580, 21% from Route 17, and only very small volumes from West Grand Avenue.

As discussed in the previous section, the average reduction in midweek travel over the Bay Bridge itself in the week immediately after the start of transbay BART service was 5,100 vehicles in the hours 6:00 a.m. to 8:00 p.m. The corresponding average reductions on each of the three freeway approaches were approximately as follows: 1,600 vehicles on Route 80, 2,400 vehicles on Route 580/24, and 1,100 vehicles on Route 17.* Thus, nearly half of the reduction in Bay Bridge traffic is attributable to the reduction in traffic approaching the Bay Bridge on Routes 580 and 24. This is consistent with the results of the transbay BART survey conducted on October 30, 1974 (described in Chapter V), which show that stations on the Concord Line paralleling Route 24 were the greatest source of diversion from automobile to BART.

Examination of the changes in the hour-by-hour distribution of traffic on the East Bay approaches to the San Francisco-Oakland Bay Bridge shows very similar patterns to those illustrated for the Bay Bridge itself in Figure III-2; namely, a reduction in traffic in the morning peak hour from 7:00 a.m. to 8:00 a.m., and even more substantial reductions later in the morning peak period. This was particularly true of Route 580 traffic which decreased by about 1,000 vehicles over the total 6:00 a.m. to 9:00 a.m. peak period. This peak period reduction on Route 580 represents about 60% of the reduction in peak period Bay Bridge traffic.

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*The figures presented here are derived from traffic counts on Routes 80, 580, and 17 conducted by CALTRANS personnel over the period September 12 to September 23, 1974. This period includes only one midweek day before the opening of transbay BART (Thursday, September 12). As a result, it is not possible to make any judgments about the statistical significance of the difference between the before and after data.

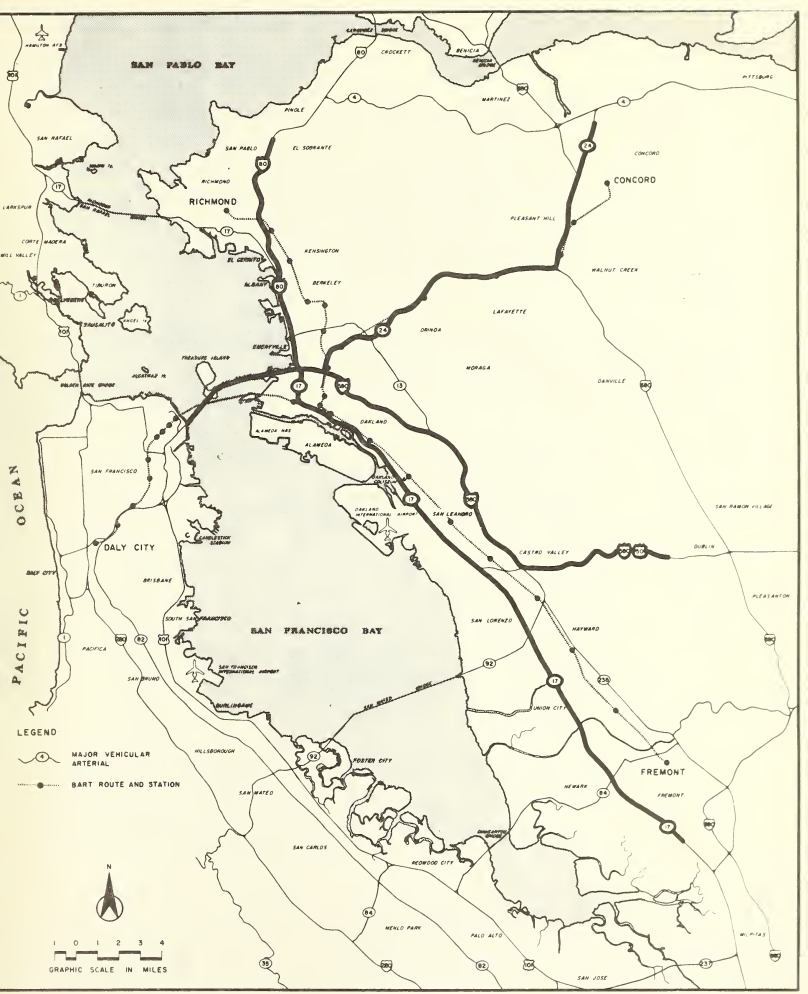

FIGURE III-3

EAST BAY FREEWAY APPROACHES TO THE SAN FRANCISCO-OAKLAND BAY BRIDGE

Long-Term Changes in Highway Traffic Volumes on the Bay Bridges

The analysis of the previous section suggests that in the week immediately after the introduction of BART service there was a drop in daily automobile travel across the Bay Bridge in excess of 5,000 vehicles per day. However, for reasons discussed later in this chapter, this estimate overstates BART's true impact in the long term. In order to allow a more realistic assessment to be made, changes in vehicle traffic on all three bridges (San Francisco-Oakland, San Mateo-Hayward, and Richmond-San Rafael Bridges) need to be analyzed over longer time periods, both before and after the start of transbay BART service.

Sources of Variation in Observed Daily Vehicle Traffic Across the Three San Francisco Bay Bridges. In assessing the changes in the travel patterns which have occurred over the period of BART's implementation, it is necessary to consider the several components making up these changes. The most important of these are:

1. Day-to-day variations in travel as a function of the day of the week, the weather, public holidays, and the like.

2. Recurrent annual seasonal patterns reflecting, among other things, vacation patterns and seasonal business cycles.

3. Long-term trends in past traffic growth reflecting the growth of the urban area, its population, economy, and automobile ownership.

4. Recent modifications to this long-term trend brought about by the shortage and associated increases in the price of gasoline, and other changes in the regional economy.

5. Travel changes brought about by BART.

Finally, there may be significant variations in the data representing changes in travel as a result of errors and inconsistencies in the measurement and recording devices. The most obvious and common source of such errors are malfunctioning traffic counters. In the absence of independent duplicate observations, these measurement errors are not generally separable from the sources of variations listed above. Nevertheless, they need to be considered in interpretation along with the five listed above.

Day-to-Day Variations in Traffic. Figure III-4 shows daily traffic across the San Francisco-Oakland Bay Bridge for a five-week period in October 1974 plotted on a day-by-day basis. The period includes October 30, the date of the transbay travel questionnaire surveys. The total number of vehicles traveling westbound across the bridge during the 24-hour day is plotted.

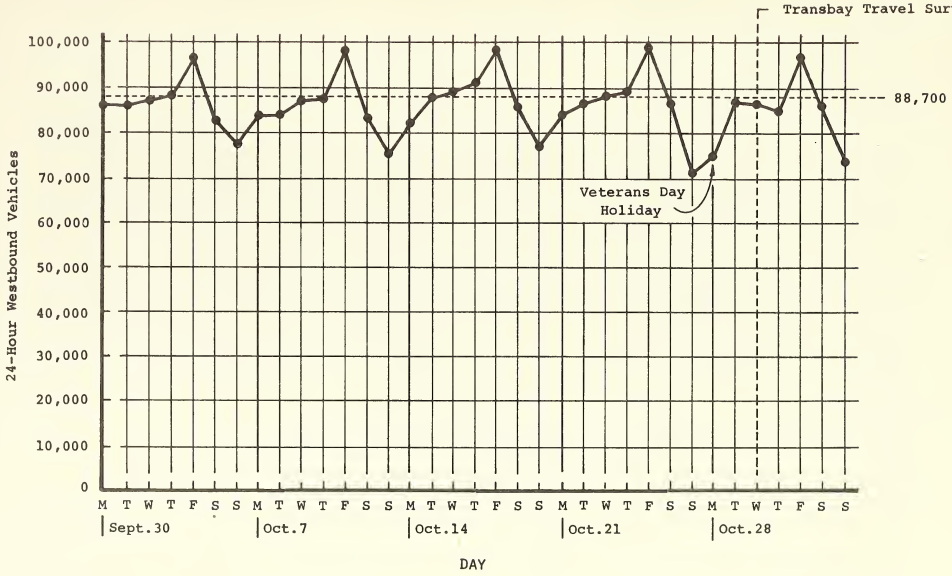

FIGURE III-4

DAY-TO-DAY VARIATION IN SAN FRANCISCO-OAKLAND BAY BRIDGE TRAFFIC, OCTOBER 1974

Source: • CALTRANS Toll Bridge Administration, Daily Totalizer Volume Counts.

The figure shows clearly the large variation in traffic by day of the week. Monday generally had the lowest weekday traffic level and Friday the highest; the difference between Monday and Friday totals is typically 14,000 daily vehicles. The figure also shows that this day-of-the-week variation was consistent from week to week. For the period illustrated in Figure III-4, only the Veterans Day holiday showed any remarkable deviation from the typical pattern. A measure of the stability of the weekly pattern is that, while the mean and standard deviation for daily traffic on all 25 weekdays in the five-week period was 88,700 and 5,600 vehicles, respectively, the mean and standard deviation for the five Wednesdays in the period was 88,000 and 700, respectively.* Thus, the variation from Wednesday to Wednesday was clearly very much smaller than the variation among all weekdays.

Analysis of day-to-day variations in traffic levels for periods other than the one illustrated in Figure III-4 show similar results. When interpreting any estimate of traffic level or change in traffic level, it is important that the magnitude of these inherent variations in the traffic count data be borne in mind.

Seasonal Variations in Traffic. Figure III-5 shows average daily vehicle traffic on the three major bridges across the San Francisco Bay: the San Francisco-Oakland Bay Bridge, the San Mateo-Hayward Bridge, and the Richmond-San Rafael Bridge, for the years 1971 to 1974. Traffic volumes are plotted for the months of January, April, July, and October in each year. Data for all weekdays in each month were used to compute the "actual" points.

The three graphs in the figure clearly illustrate the marked seasonal variation in traffic over the three bridges. In relative terms, traffic was typically low in January, high in July, and at levels close to the average in April and October. For the San Francisco-Oakland Bay Bridge, this pattern was distorted in 1974 by the effects of the AC Transit bus strike during July and August which caused an exaggeration of the July peak.

Also shown in Figure III-5 are estimates of the underlying trends of traffic growth for the three bridges. These trend lines are linear regression estimates computed using the 12 data points for the years 1971, 1972, and 1973. Data points for 1974 have not been included, since these reflect the distorting influences of the gasoline shortage and price increases in the early part of the year, the AC Transit strike in July and August, as well as the start of transbay BART service in September. For any given month, the difference between the actual traffic level and the trend line value gives an estimate

*These estimates imply that the 95% confidence limits for the mean of all 25 weekdays in October 1974 are 88,700 plus or minus 2,300 vehicles. The 95% confidence limits for the mean of the 5 Wednesdays are 88,000 plus or minus 900 vehicles.

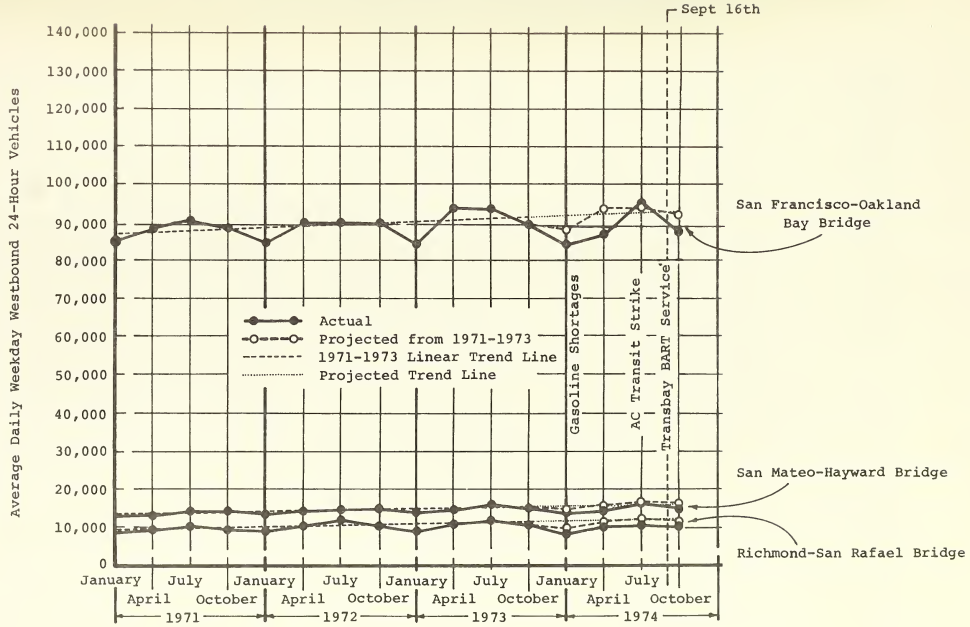

FIGURE III-5

TOTAL VEHICLE TRAFFIC ON THE THREE SAN FRANCISCO BAY BRIDGES
JANUARY 1971 - OCTOBER 1974

Source: • CALTRANS Toll Bridge Administration, Daily Totalizer Volume Counts.

of the seasonal component of traffic for that month.* Taking the average of this seasonal component for the three months of January 1971, 1972, and 1973 thus gives an estimate of the typical January seasonal component. Similarly, seasonal components can be estimated for the months of April, July, and October.

Seasonal Variations in Traffic on the San Francisco-Oakland Bay Bridge. For the three years 1971 to 1973, average daily January traffic on the San Francisco-Oakland Bay Bridge was about 3,600 vehicles below trend; April traffic was 1,900 vehicles above trend; July traffic was 2,200 vehicles above trend; and October traffic was 500 vehicles below trend. Thus, within the year, daily Bay Bridge weekday traffic typically varied by about 6,000 vehicles from summer to winter. Equivalently, if the mean traffic level for any year is taken as a base of 100, these seasonal levels can be expressed as indices of 96 for January, 102 for April, 102 for July, and 99 for October; or a total variation between summer and winter of about 6% of the annual average.** These seasonal variations in traffic need to be emphasized since they may be crucially important when comparisons are made between traffic levels observed at different times of the year.

Seasonal Variations in Traffic on the San Mateo-Hayward Bridge. A similar, but slightly less pronounced, seasonal pattern emerged from comparison of the actual traffic levels with the trend-line estimates for the San Mateo-Hayward Bridge. For the years 1971 through 1973, average weekday traffic in January was about 600 vehicles less than trend; in April, 100 vehicles less than trend; in July, 500 vehicles more than trend; and in October, 200 vehicles more than trend. Average weekday traffic over the three-year period was about 15,000 vehicles, so that expressed relative to a mean traffic level index of 100, typical seasonal traffic levels were 96, 99, 103, and 101 in January, April, July, and October, respectively.

Seasonal Variations in Traffic on the Richmond-San Rafael Bridge. On the Richmond-San Rafael Bridge an even more obvious pattern of seasonal variation in traffic level, similar in form to both the other two bridges, was apparent. January traffic was typically about 900 vehicles below trend; April at about trend; July, 1,000 vehicles above trend; and October, 100 vehicles below trend. The mean weekday traffic level over the three-year

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*This estimate implies a simple additive model which asserts that traffic levels are the sum of two components: (1) a linear "trend" component of the form $a + b.t$; where "t" is time, and "a" and "b" are constants, and (2) a seasonal component which is a constant for any given month of the year.

**Over the whole three-year period 1971 to 1973, the mean traffic level was about 90,000 vehicles per day.

period 1971 through 1973 was about 11,000 vehicles; so that on a base of 100, these levels can be expressed as indices of 92, 100, 109, and 99 for January, April, July, and October, respectively.

Underlying Long-Run Trends in Traffic Growth. The estimates of seasonal traffic components presented above must be regarded as fairly crude measures, since they were computed from only three years of data. Nevertheless, they do allow the seasonal component of traffic variation to be accounted for, thereby allowing underlying "true" changes in traffic to be seen more clearly.

In addition to the seasonal pattern, a steady upward trend in traffic levels over the years 1971 to 1973 is apparent from the data shown in Figure III-5. On the San Francisco-Oakland Bay Bridge the regression line shows an annual increase of 1,700 daily vehicles, or 2% per annum over the period. The corresponding slope for the San Mateo-Hayward Bridge was 900 daily vehicles or a 6% per annum average increase. On the Richmond-San Rafael Bridge, the increase was 700 vehicles per annum, an average increase of 7%.

Projections of Traffic Levels for 1974 Based on Trend and Seasonal Components. As a basis of comparison with the actual traffic levels on the three bridges in 1974, the linear regression trend lines computed over the years 1971 to 1973 have been projected forward to 1974. These provide a basis for estimating "what might have been" if there had not been a gasoline crisis and if transbay BART had not started service. Estimates of traffic in January, April, July, and October 1974, including the seasonal component, are shown as points connected by dashed lines in Figure III-5. These points represent the average traffic levels that would have been predicted for these four months assuming (1) a continuation of the linear trend in traffic growth underlying the period 1971 through 1973, and (2) superimposed on the linear trend line, a pattern of seasonal variation in 1974, the same as was typical for the years 1971 through 1973.* The actual observed traffic levels and these trend estimates allow a number of useful comparisons to be drawn, bearing in mind that January, April, and July 1974 are all periods before the start of transbay BART service, and October 1974 represents a time immediately after the start of transbay BART service.

Comparison of Actual and Predicted Traffic. Comparisons of the actual and predicted traffic levels for January and April 1974 show that actual traffic was substantially lower than the trend for all three bridges. These reductions presumably reflect the effects of the gasoline shortage and associated price increases over the winter of 1973-1974. On the San Francisco-Oakland Bay Bridge, the actual levels for January and April

*The seasonal component for each of the months of January, April, July, and August was computed by taking the average of the residuals about the regression line for the years 1971, 1972, and 1973.

were, respectively, 4% (3,500 vehicles) and 7% (6,900 vehicles) below the predicted levels. For the San Mateo-Hayward Bridge, the corresponding figures for January and April were 8% (1,200 vehicles) and 9% (1,500 vehicles), respectively. Traffic on the Richmond-San Rafael Bridge was 11% (1,200 vehicles) below the predicted level for both January and April 1974.*

The data points for July 1974 reflect both a continuation of the gasoline shortage-induced reduction in traffic and the effects of the AC Transit strike which lasted throughout the month. Traffic on the Richmond-San Rafael Bridge, which was not significantly affected by the strike, continued the pattern of January and April and was well (16% or 2,100 vehicles) below the trend prediction. On the San Mateo-Hayward Bridge, which carried some traffic diverted from the San Francisco-Oakland Bay Bridge during the strike, the actual average weekday traffic in July 1974 was 3% (300 vehicles) below the trend prediction, compared to 9% in April. Daily traffic on the San Francisco-Oakland Bay Bridge, which bore the main traffic impact of the AC Transit strike, was slightly (1% or 700 vehicles) above the trend prediction for the month, compared to being 7% (6,900 vehicles) below the trend in April.

Given the complicating effects of the AC Transit strike, the data for July 1974 were thus of little help in interpreting the situation in October 1974 (i.e., the post-BART situation).

Comparison of the actual data points with the trend-line estimates of traffic for October 1974 shows that on all three bridges, actual traffic levels were lower than predicted by margins very similar to those observed in January and April. Thus, traffic on the San Francisco-Oakland Bay Bridge was down 5% (4,800 vehicles) from the level predicted by the trend (compared to 4% in January and 7% in April). Traffic on the San Mateo-Hayward Bridge was down 7% (1,200 vehicles), compared to 8% in January and 9% in April. Richmond-San Rafael Bridge traffic was down 12% (1,400 vehicles), compared to 11% in both January and April.

Comparison of the Actual October Traffic Levels in 1971, 1972, 1973, and 1974. Simple comparisons between average daily traffic levels in October 1974 and in previous Octobers is another (and more usually employed) way of separating out the seasonal component of traffic variation, although not the secular trend. These comparisons of the actual data for the three bridges show results which are consistent with those summarized in the previous section.

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*Caution needs to be exercised in comparing traffic levels among the three bridges to the extent that the nature of the traffic is rather different with regard to purpose of travel and distribution over time.

Average daily traffic levels on the San Francisco-Oakland Bay Bridge were 89,400 vehicles in October 1971, 90,600 in October 1972, and 90,500 in October 1973. Average daily traffic in October 1974 was 88,700 vehicles or 1,800 (2%) below October 1973.

On the San Mateo-Hayward Bridge average daily traffic was 14,600 vehicles in October 1971, 15,100 vehicles in October 1972, and 15,900 vehicles in October 1973. Average daily traffic in October 1974 was 15,700 or 200 vehicles (1%) below the October 1973 level.

On the Richmond-San Rafael Bridge average daily traffic was 9,900 vehicles in October 1971, 10,900 in October 1972, and 11,400 in October 1973. In October 1974, daily traffic averaged 10,700 vehicles, 700 (6%) fewer than in October 1973.

Conclusions. It was expected that the opening of BART service would reduce traffic on the San Francisco-Oakland Bay Bridge to a much greater extent than on the San Mateo-Hayward Bridge and that traffic on the Richmond-San Rafael Bridge would probably not be affected by transbay BART in any detectable way. Thus, in attempting to determine the extent to which BART has reduced traffic on the Bay Bridge, two sets of comparisons are meaningful: comparisons of traffic levels on the Bay Bridge with the two other bridges, and comparisons of the October 1974 post-BART traffic levels with pre-BART traffic levels.

As detailed in the preceding sections, these comparisons provide no basis for concluding that any significant reduction in 24-hour traffic on the Bay Bridge can be attributed to transbay BART's opening in the context of the traffic-reducing effects of the gasoline shortage and other changes in the characteristics of the transportation system. For example, in percentage terms (although not in absolute numbers), reductions in vehicle traffic on the San Mateo and Richmond Bridges have, relative to the trend predictions, been greater than on the Bay Bridge.

Changes in Total Travel by All Modes in the San Francisco-Oakland Bay Bridge Corridor

The previous section considered only aggregate 24-hour vehicle traffic volumes. More meaningful analyses of the impacts of transbay BART on travel in the San Francisco-Oakland Bay Bridge corridor requires (1) that analysis be concentrated on the 14-hour period when BART operates, particularly over the morning and evening peak travel periods; and (2) that total travel by bus and BART, as well as private automobile, be considered. These analyses are presented in this section.

Figure III-6 shows weekday westbound passenger travel across the San Francisco-Oakland Bay Bridge by bus, BART, and automobile in the 14 hours from 6:00 a.m. to 8:00 p.m. (the hours of BART operation). Included

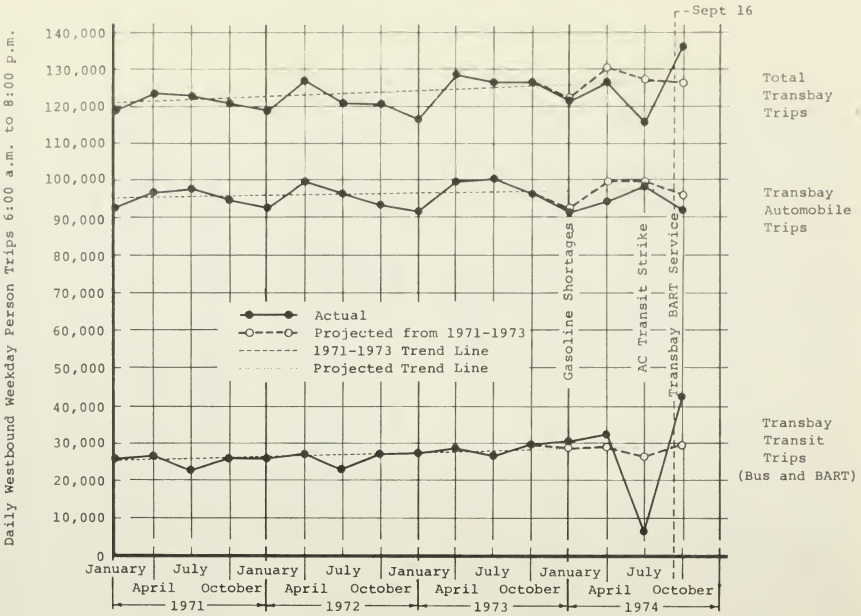

FIGURE III-6

SAN FRANCISCO-OAKLAND BAY BRIDGE WESTBOUND WEEKDAY PERSON TRIPS BY MODE
JANUARY 1971 - OCTOBER 1974

Sources:
- CALTRANS Toll Bridge Administration, Daily Totalizer Volume Counts.
- University of California, ITTE, Bay Bridge Vehicle Classification and Occupancy Surveys.
- AC Transit District, Daily Passenger Counts.
- Greyhound Lines, Inc., Contra Costa County Commute Service Passenger Counts provided to

in these data are trips by persons in private automobiles, AC Transit, and Greyhound buses across the San Francisco-Oakland Bay Bridge, and by transbay BART. As in the previous section, data for average weekday travel in January, April, July, and October of 1971 through 1974 are shown. Also shown in Figure III-6 is a linear regression trend line computed from the data points for 1971 through 1973 and projected forward to 1974.

Seasonal and underlying trend components of travel are apparent from the graphs in the figure for both automobile and bus travel across the bridge. Over the 1971 through 1973 period, bus travel showed an average annual increase of 1,200 daily trips (5% increase per annum). Automobile travel increased by an average of 800 daily trips (1%) per year over the same period, and total travel by the aggregate of 2,000 daily trips or 2% per year.

Estimates of the seasonal component of variation in travel have been computed from the residuals of the regression equation in the same way as was done for the vehicle traffic analysis of the previous section.* The sum of the regression trend estimates and the seasonal component estimates are shown in Figure III-6 for January, April, July, and October 1974. These "predicted" points (which can be considered as "seasonally adjusted trend" estimates) are joined by the dashed line.

A large number of comparisons could be made on the basis of the data shown in Figure III-6. The most meaningful of these are:

1. Comparisons of post-transbay travel with the travel levels predicted by the trend and seasonal components of previous years.

2. Comparisons of post-transbay travel with travel levels for the same period in previous years.

Transit Ridership in the San Francisco-Oakland Bay Bridge Corridor. Comparison of trips made by transbay bus before BART with the sum of trips made by transbay bus and BART shows a substantial increase in total transit ridership. Daily trips by transit averaged 43,300 in October 1974. This is an excess of 13,200 (44%) over the level predicted by the seasonally adjusted trend; an increase of 13,500 (45%) over the level of October 1973; and increases of 16,500 (62%) and 17,100 (65%) over the levels of October 1972 and 1971, respectively. The start of transbay BART service has thus clearly attracted a large number of travelers to transit.

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*Correspondingly, the estimates imply the same simple "linear trend plus seasonal" model of trip volumes as was postulated in the vehicle traffic analysis.

Automobile Ridership Across the San Francisco-Oakland Bay Bridge. Transbay travel by automobile in October 1974 was less than that predicted by the long-run trend. The actual number of trips made in private automobiles averaged 93,200 in October 1974. This compares to a level of 96,700 predicted by the trend, or a difference of 3,500 daily trips (4%). Comparison with the level for October 1973 shows a similar decrease of 3,600 daily trips. This change is statistically significant at the 5% significance level. Study of the data for a longer period confirms this decrease. Comparison of the three-month period October through December 1974 shows an average daily trip level of 93,300 in 1974 compared to 96,100 in 1973, a decrease of 2,800 trips (3%).

However, comparisons of automobile travel in 1974 with 1972 and 1971 show much smaller decreases. Relative to October 1972, the data show that there was a decrease of 700 daily trips (1%) in October 1974. However, the data for October 1972 reveal an abnormally high variance, suggesting errors in the traffic counts. As a consequence, the change from 1972 to 1974 cannot be considered statistically significant from zero at a 5% significance level. Relative to October 1971, the October 1974 traffic level showed a decrease of 1,700 daily trips (2%) which is a statistically significant difference at the 5% significance level. The reductions in automobile travel suggested by these data are clearly much smaller than the corresponding increases in transit ridership summarized in the previous section.

Comparison of Changes in San Francisco-Oakland Bay Bridge Automobile Travel. The analysis of changes in Bay Bridge traffic in the weeks immediately before and after the start of transbay BART, which were discussed at the beginning of this chapter, showed a decrease of about 7,000 daily automobile person-trips from a level of about 100,000 trips. The decrease in trips over the period from October 1973 to October 1974 is shown by this "long-term" analysis to be about 3,000 trips per day. These figures imply an increase of about 4,000 daily trips in the period between October 1973 and September 1974. This implies, in turn, that some influence other than BART increased San Francisco-Oakland Bay Bridge traffic substantially over the period.

However, the possibility that this was a "real" increase in travel is contradicted by the fact that traffic levels were substantially below trend for the San Francisco-Oakland Bay Bridge in January and April 1974. (July traffic levels were distorted by the effects of the AC Transit strike.) Traffic levels on the San Mateo-Hayward and Richmond-San Rafael Bridges for January, April, and July 1974 were similarly substantially below trend.

The explanation for this apparent inconsistency probably lies in the fact that the AC Transit strike of July and August 1974 ended only two weeks before the start of transbay BART service. Consequently, it was necessary to use the traffic levels in this two-week period as the "before" data point for the immediate impacts assessment presented at the beginning of this chapter. It is likely that many transbay automobile trips, which were suppressed

during the strike as a result of increased highway traffic congestion, were made during this two-week period thereby "artificially" increasing highway traffic levels in the immediate before-BART period. Thus, the estimate of 100,000 daily transbay automobile trips in early September 1974 is probably significantly inflated.* Correspondingly, the estimate of a reduction of 5,000 daily vehicles as the immediate impact of transbay BART on San Francisco-Oakland Bay Bridge automobile traffic overstates the true "immediate" impact.

Total Travel in the San Francisco-Oakland Bay Bridge Corridor. The graph shown in Figure III-6 for the aggregate of transit and automobile trips reflects the fact that the decrease in automobile travel was much less than the increase in travel on transit. The total number of weekday trips by automobile, bus, and BART combined averaged 136,500 per day in October 1974. This is 9,700 (8%) higher than the trend prediction and 9,900 (8%) higher than the level in October 1973. Correspondingly, comparison with October 1972 shows an increase of 15,800 trips (13%), and with October 1971, an increase of 15,400 trips (13%).

The trend lines quoted in these comparisons were computed for a period January 1971 through October 1973. The underlying rate of increase of 2,000 trips per day suggested by this trend must, therefore, be considered an optimistic indicator of travel in 1974 given the likely constraining effects on automobile travel of the gasoline shortage, associated price increases, the general recession of the economy, and possibly the capacity constraints of the Bay Bridge itself. That is to say, some part of the decrease in automobile travel (and hence total travel) before and after BART may well be attributable to causes other than BART. Thus, the before-and-after transbay BART increase of 9,700 trips per day over and above the trend (which itself projects an annual increase of 2,000 trips) may be considered a lower bound on the increase in total travel in the period October 1973 to October 1974. In other words, the increase in total travel attributable to transbay BART has probably been no less than 9,700 trips per day and may have been considerably more.

In summary, the effect of BART on transbay travel has thus apparently been to increase travel by transit substantially (13,200 daily trips) and to decrease automobile travel by a much smaller amount (3,500 daily trips), with the net effect of increasing total transbay travel by 9,700 trips per day.

Modal Composition of Transbay Travel Before and After BART. Table III-1 summarizes the pattern of average weekday transbay travel by mode, comparing the actual distribution for October 1974 with that which

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*This high traffic volume may also have included drivers who had bought books of prepaid toll tickets in anticipation of the strike continuing, and others, like car poolers, who would have reverted to transit eventually.

Table III-1

PREVIOUS MODE OF TRANSBAY TRIPS
Average Weekday Westbound Person-Trips[a]
(6:00 a.m. to 8:00 p.m.)

Trips Previously Made By	October 1974 Transbay Trips Made By			Total Trips Previously Made
	Automobile	Bus	BART	
Automobile	86,000	--	10,000[b]	96,000
Bus	--	18,000	13,000[c]	31,000
No Trip Made	7,000	--	2,000	9,000
Total Trips Actually Made in October 1974:	93,000	18,000	25,000	136,000

a. All numbers are approximate.
b. Of those BART riders who previously traveled by automobile, 8,000 drove alone and 2,000 traveled with others.
c. Of those BART riders who previously traveled by bus, 4,000 rode Greyhound buses (from Contra Costa County) and 9,000 rode AC Transit buses.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

would have occurred hypothetically had BART not been in operation at that time. In constructing the table, it has been assumed that there has been no significant diversion of travelers to bus as a result of BART's opening; nor has there been a diversion from bus to automobile. The distribution of BART trips among automobile, bus, and "no trip made" has been estimated on the basis of responses to an October 1974 transbay BART survey question regarding the previous mode of travel.* The "trips previously made" (without BART) totals have been derived from the October 1973 traffic count averages and the trend-line estimates of traffic shown in Figure III-6. Numbers in the table are approximate, reflecting the need to "balance" the various estimating errors involved, but in all cases are accurate to within 1,000 trips of the estimates displayed in Figure III-6.

Possible Causes of Changes in Transbay Travel. According to the analysis of previous mode summarized in Table III-1, it can be inferred that, of the transbay trips being made in October 1974, approximately 9,000 would not have been made had BART service not started under the Bay. Of these, no more than about 2,000 were being made on BART itself. The remaining 7,000 trips were being made by automobile. These 7,000 trips correspond to about 5,000 vehicles, or 7% of the total vehicles using the Bay Bridge between 6:00 a.m. and 8:00 p.m.

Five major sources for the apparent additional automobile trips may be hypothesized:

1. Transbay trips that would otherwise have been made via the San Mateo-Hayward Bridge.

2. Trips that would not have been made across the Bay at all, but have been induced as a result of reduced congestion on the Bay Bridge.

3. Trips that for the same reason would otherwise have been made before 6:00 a.m. or after 8:00 p.m.

4. Trips that were made previously but now are being made at lower automobile occupancies.

5. Trips that have been newly generated for reasons not directly related to BART.

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*Responses to the October 1974 survey of BART travelers indicated that 54% of transbay BART trips were trips which had previously been made by bus, 35% were trips which had been made by automobile, and 11% were trips which had not been made prior to BART's opening. As discussed more fully in Chapter V, the latter should be considered a high estimate of the trips truly "induced" by BART.

Diversion of Travel from Other Routes. As shown in Figure III-5, October 1974 daily traffic over the San Mateo-Hayward Bridge was at about the same level as it was in October 1973. Traffic was some 1,200 vehicles (7%) below the trend level for October 1974, but some part of this is most likely accounted for by causes other than BART, as evidenced by a similar reduction of 1,400 vehicles (12%) on the Richmond-San Rafael Bridge which is unlikely to have been affected by BART. Traffic on the San Mateo-Hayward Bridge in April and July 1974 was also significantly lower than the previous year. It seems likely, therefore, that only a small proportion, if any, of the 5,000 vehicle trips generated on the San Francisco-Oakland Bay Bridge have been diverted from the other bridges.

Diversion of Travel from Other Times of Day. Regular surveys of the San Francisco-Oakland Bay Bridge carried out by University of California ITTE and CALTRANS staff have shown a consistent pattern of traffic distribution during the day. Over the last three years between 85% and 87% of all westbound vehicle traffic has occurred within the hours of 6:00 a.m. to 8:00 p.m. The estimate for October 1974 (86.2%), gives no indication that the additional Bay Bridge automobile traffic is accounted for by the third of the above hypotheses.

Changes in Automobile Occupancy. It might be supposed that a reduction in automobile occupancy would have the effect of increasing apparent automobile trip-making. However, automobile occupancy has been taken into account in the estimates of automobile person-trips. In any event, automobile occupancy has not changed greatly. According to the University of California ITTE annual Bay Bridge surveys of the past three years, automobile occupancy over the 12-hour period, 6:30 a.m. to 6:30 p.m., was 1.43 in October 1972, 1.43 in October 1973, and 1.42 in October 1974.

Trips Generated by Causes Not Directly Related to BART. It is possible that there has been an increase in travel in the San Francisco-Oakland Bay Bridge corridor which is unrelated to BART. However, an increase on the order of 7,000 trips seems unlikely, given available evidence on traffic levels on the Bay Bridge earlier in the year and traffic levels on the other two bridges over the Bay.

Interpretation of Observed Changes in Aggregate Transbay Travel Patterns

The conclusion, therefore, remains that in the period immediately after BART's opening, there has indeed been a significant increase in total travel across the San Francisco-Oakland Bay Bridge screenline which has been offset only in part by the diversion of automobile traffic to BART. The October 1974 surveys of transbay travel did not ask travelers their reasons for making trips not previously made. Consequently, the survey results do not explain the source of the 7,000 apparently new automobile trips. However, a likely reason can be hypothesized as follows.

Before the opening of transbay BART, over much of the day, the capacity of the Bay Bridge was being approached by the volume of vehicles using it, with resulting congestion and delay. As a result, many potential transbay trips may have been suppressed. The diversion of traffic from automobile to BART increased the transportation capacity of the Bay Bridge corridor, thereby reducing traffic congestion and delay and so allowing the suppressed trips to be made. To the extent that this is true (as is suggested by the analyses of Chapter IV), it seems reasonable to suppose that many of the new transbay automobile trips have indeed been indirectly caused by BART.

It may be supposed that some of these were new trips which were previously made to destinations on the same side of the Bay and which, because of effectively improved highway accessibility, were being made transbay to alternative and presumably more attractive destinations. Others were trips which were "induced," in that they would not have been made at all (or would have been made less frequently), given the previous level of highway accessibility.

On the order of 10,000 automobile trips have been diverted to BART, but some 7,000 new automobile trips have apparently been generated, giving a net decrease of about 3,000 automobile person-trips over the 6:00 a.m. to 8:00 p.m. day. This is approximately equivalent to a decrease of 2,000 vehicle trips, or about 3% of the October 1974 14-hour daily vehicle total.

In order to put these figures in perspective, it should be restated that over the three years 1971 to 1973, the trend in San Francisco-Oakland Bay Bridge automobile trips was an average annual increase of 2,000 daily person-trips in the 6:00 a.m. to 8:00 p.m. day. Typically, average daily travel may have been as much as 4,000 daily trips above or below the annual mean at different times of year due to purely seasonal variations. Variation among days of the week is also such that there was often a difference of 15,000 daily trips between the highest weekday (Friday) and the lowest weekday (Monday). Finally, there were variations in average weekday traffic levels from week to week. For example, an estimate of daily transbay travel computed as the mean of all Wednesdays in a given month can typically be considered as having meaning only within a 95% confidence bound of about 1,000 daily trips above or below the mean estimate.

Viewed in the context of all these sources of variation, the changes in Bay Bridge automobile travel which have occurred over the period before and after the opening of transbay BART must be viewed as significant, but nevertheless small, in relation to the total volume of transbay travel. The reduction in automobile travel represents on the order of one or two years secular growth in Bay Bridge travel, and is of the same order as normal week-to-week variation. Finally, it must be repeated that some part of this decrease in automobile travel may be attributable to influences other than BART, such as the increase in gasoline prices.

IV. SAN FRANCISCO-OAKLAND BAY BRIDGE HIGHWAY TRAFFIC CONGESTION

Hourly Distribution of San Francisco-Oakland Bay Bridge Traffic

As shown in the previous chapter, the reduction in 24-hour Bay Bridge traffic before and after the opening of transbay BART was about 2,000 vehicles for an average weekday. The distribution of this change in traffic over the hours of the day is of interest, especially to the extent to which there was a reduction in peak period traffic.

Figure IV-1 shows the hour-by-hour distribution of westbound Bay Bridge traffic for two typical midweek days in October 1973 and October 1974 (Wednesday, October 17, 1973 and Wednesday, October 23, 1974).* A marked concentration of traffic in the morning peak period is obvious for both distributions. The evening peak is much less pronounced. The evening peak pattern is also very similar for both distributions, but the October 1974 distribution shows a markedly shorter duration of very high morning traffic levels than was the case in October 1973. The pattern of traffic over the remainder of the day shows no great difference.

Clearly, it is not possible to draw a meaningful conclusion from comparison of only these two days of data. However, data describing the distribution of travel in the morning peak period over several weeks point to the same conclusion. In the figures compared below total westbound traffic in the hours from 6 a.m. to 10 a.m. were analyzed for all Wednesdays in October, November, and December 1973 and 1974 (omitting the Wednesday before Thanksgiving in each case). Total 24-hour traffic on these days averaged 89,900 vehicles in 1973 and 87,810 vehicles in 1974, a difference of 2,090 vehicles.

Comparison of the traffic volume for the two-hour peak period from 7 a.m. to 9 a.m. shows, contrary to expectations, a small (and statistically insignificant) increase of 240 vehicles per hour in 1974 over the 1973 level. However, on either side of this two-hour peak period, there were significant reductions from 1973 to 1974. There was a difference of 770 vehicles (12%) in the mean estimates for the hour 6 a.m. to 7 a.m. and a mean difference of 360 vehicles (6%) for the hour 9 a.m. to 10 a.m. Both of these differences are significant at the 5% level. Overall, the difference between the means for the four-hour peak period from 6 a.m. to 10 a.m. was 650 vehicles.

These results confirm the impression given by Figure IV-1 that there has been little change in the traffic volume on the San Francisco-Oakland Bay Bridge at the peak itself, but there has been a significant reduction in the duration of the period over which very high volumes of traffic are carried. As has already been hypothesized, this may be explained by people

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*The difference in total 24-hour traffic for these two days was actually 1,400 vehicles, a slightly lower difference than the average difference for all weekdays in the two months. The two distributions are nevertheless representative for purposes of illustration.

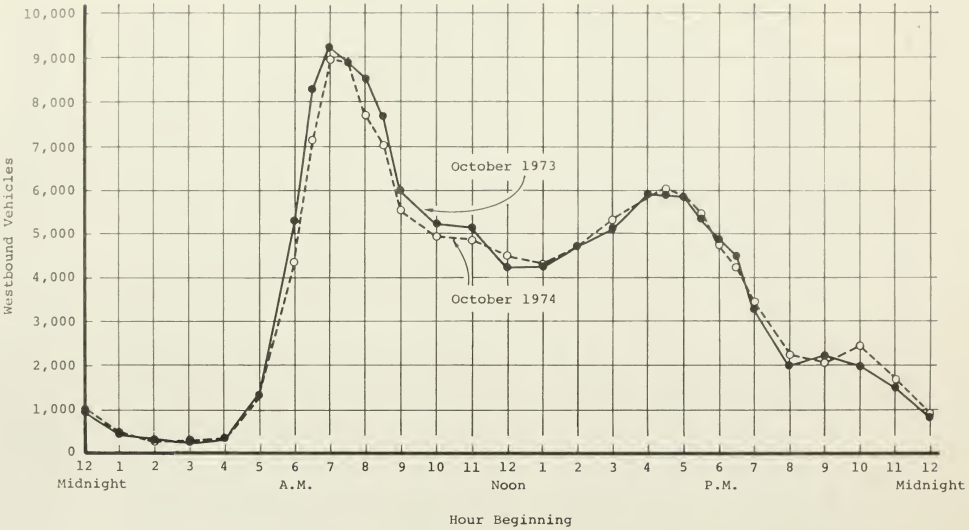

FIGURE IV-1

SAN FRANCISCO-OAKLAND BAY BRIDGE WESTBOUND VEHICLE TRAFFIC
TYPICAL MIDWEEK DISTRIBUTION OF TRAFFIC OVER THE DAY, OCTOBER 1973 AND OCTOBER 1974

Source: • University of California ITTE, October Surveys of Bay Bridge Traffic

traveling at more desirable times (either earlier or later) as a consequence of the reduction in highway congestion caused by the removal of traffic to BART.

Period of Activation of the San Francisco-Oakland Bay Bridge Traffic Metering System

Since March 14, 1974, a system of metering westbound traffic entering the 5 lanes of the San Francisco-Oakland Bay Bridge has been operational. The flow of traffic leaving the 17 toll booth lanes is controlled by a red or green traffic light above each lane at a point about 0.2 miles past the toll gates and 0.6 miles before the pavement merges into 5 lanes at the beginning of the bridge structure itself. The traffic lights are operated automatically by detectors which monitor the speed of vehicles entering the bridge. At normal speeds all lanes show a green light. The metering system is activated (and shows periodic red lights above lanes) when traffic speeds fall below some prespecified level indicating a build up of congestion on the bridge.* Thus, the starting time and period of duration of the metering system are interesting measures of congestion on the Bay Bridge for which data are available on a continuing and consistent basis. Figure IV-2 shows the times of activation of the system during the morning peak period for Tuesdays, Wednesdays, and Thursdays, day-by-day, for the period from March 14, 1974 until the end of the year. Gaps in the figure indicate days for which data are not available.

Figure IV-2 indicates a fairly consistent pattern of traffic congestion over the period March to June 1974 with day-to-day variations about the norm caused by the weather, traffic accidents, and other influences. The starting time, duration, and day-to-day variations in the duration of the metering period all increased dramatically in July and August of 1974 giving a clear picture of the traffic congestion caused by the AC Transit strike in those two months. The period of activation then decreased markedly in September at the time of transbay BART servive introduction. However, by December, the period appears to increase back to higher levels, close to those of the early part of the year.

Over the 15 weeks from March 19 until June 27, 1974 (the period between the start of the metering system and the start of the AC Transit strike), the period of activation of the metering system in the morning peak period averaged 88 minutes for midweek travel. The standard deviation about this mean was 17 minutes. Over the 14-week period from September 17 (the day after transbay BART service startup) to December 19, 1974, the average period of activation of the metering system over the midweek morning peak period was 73 minutes, (with a standard deviation of 20 minutes about this

*The special priority car pool and bus lanes show a green light at all times.

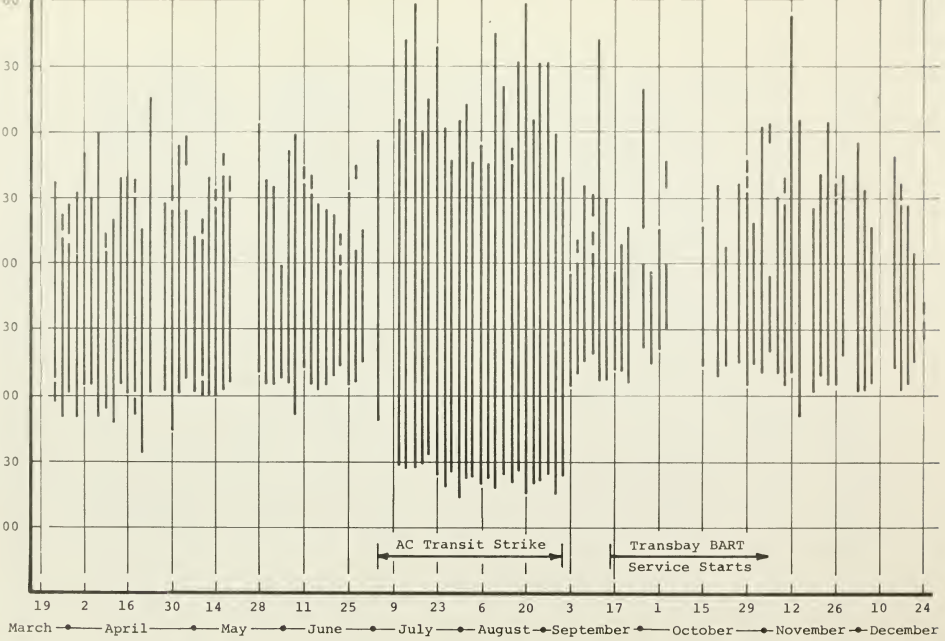

FIGURE IV-2

PERIOD OF ACTIVATION OF THE SAN FRANCISCO-OAKLAND BAY BRIDGE TRAFFIC METERING SYSTEM
TUESDAYS, WEDNESDAYS AND THURSDAYS, MARCH 1974 - NOVEMBER 1974

Source: • CALTRANS Toll Bridge Administration, Daily Records of Bay Bridge Metering System.

mean).* The difference between these two means is 15 minutes, which is a statistically significant difference at well beyond a 5% significance level. With the exception of the July-August vacation period (which is omitted from the above comparison), seasonal variations in peak period traffic were not large, so this difference may be attributed to BART-induced changes in Bay Bridge traffic with some confidence. This conclusion corroborates the findings of the previous section that there was a significant shortening of the peak in the period immediately following the start of transbay BART service. This was probably caused by the diversion of travel to BART and a consequent time-redistribution of automobile trips within the peak period.

It is interesting to note that in the three weeks immediately following the opening of transbay BART (September 17 to October 3, 1974), the average period of activation of the metering system in the morning peak was only 52 minutes (standard deviation = 11 minutes). In the four weeks of October 15 to November 7, the average was 75 minutes (standard deviation = 18 minutes), and in the five weeks of November 19 to December 19, 83 minutes (standard deviation = 16 minutes).**

These estimates should be interpreted warily, since they are derived from small sample sizes and also include some seasonal component of variation. However, they do suggest that after a substantial reduction in morning peak period congestion immediately following the start of BART service, there was a steady increase in the peak period traffic in the last three months of 1974 to a point where congestion was at a level only slightly below the average for earlier in the year. In fact, at a 5% significance level, the mean estimate of 83 minutes for the November to December period cannot be considered statistically different from the mean of 88 minutes estimated for the March to June period.***

Peak Period Highway Travel Times on the San Francisco-Oakland Bay Bridge and Its Approaches****

A relatively small travel time data set for the "after transbay BART" situation was collected specifically for this analysis over a period from two to six weeks after the start of transbay BART service. Many more data exist

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*Days for which the data are suspect because of either recording problems or major accident holdups have been excluded. A total of 38 days' data is included in the 88-minute mean estimate and 26 days' data in the 73-minute estimate.

**Data were not available for the weeks of October 8 and November 12, 1974.

***This is consistent with the finding that 24-hour traffic on the Bay Bridge may have increased by up to 2,000 vehicles over the period October to December 1974 (see Chapter V).

****The highway travel time data analyzed in this section were collected by CALTRANS personnel using the "moving car observer" method, with travel times recorded on tachographs. Data were observed on Tuesdays, Wednesdays, and Thursdays only.

for the "before transbay BART" situation. However, these "before" data were not specifically collected for the same purpose. As a result, the set of data available for a before-and-after comparison of travel times limits the analysis to a fairly small number of highway routes. Also, data for days when there were abnormally high travel times, indicating unusually severe congestion, were omitted from the data for analysis. The number of data points considered here are therefore small, ranging from zero to four travel time observations for a given route and time of day. This precludes any meaningful statistical tests of differences between the before-and-after transbay BART data. Nevertheless, it is possible to compare the mean travel times from the two data sets and draw some conclusions about changes in traffic segments. Six highway segments are considered, as follows. Locations are identified in Figure IV-3.

Morning Peak Period Westbound Travel Time Analysis Segments

1. Route 80 (the San Francisco-Oakland Bay Bridge) from West Grand Avenue (just before the toll plaza) westbound to Treasure Island (midway across the bridge); a distance of 3.2 miles.

2. Route 80 from McBryde Avenue southbound to the intersection with Routes 580 and 17; a distance of 8.8 miles.

3. Route 580 from Oakland Avenue westbound to West Grand Avenue (just before the toll plaza); a distance of 3.0 miles.

4. Route 17 from 98th Avenue northbound to Sixth Avenue (just before the intersection with Routes 580 and 80); a distance of 5.6 miles.

Evening Peak Period Eastbound Travel Time Analysis Segments

5. Route 101 from Army Street northbound to the intersection with Route 480 (just before the Bay Bridge); a distance of 2.6 miles.

6. Route 80 from the intersection with Routes 580 and 17, northbound to San Pablo Avenue; a distance of 8.0 miles.

The following figures show, for each of these highway segments, two plots of average travel times; one for the "before transbay BART" situation and one for the "after transbay BART" situation. The travel times are shown distributed over the peak period by the time of day at which the travel run began. On each figure, the date of data collection and the number of points used in computing the averages are shown. Many of the "before

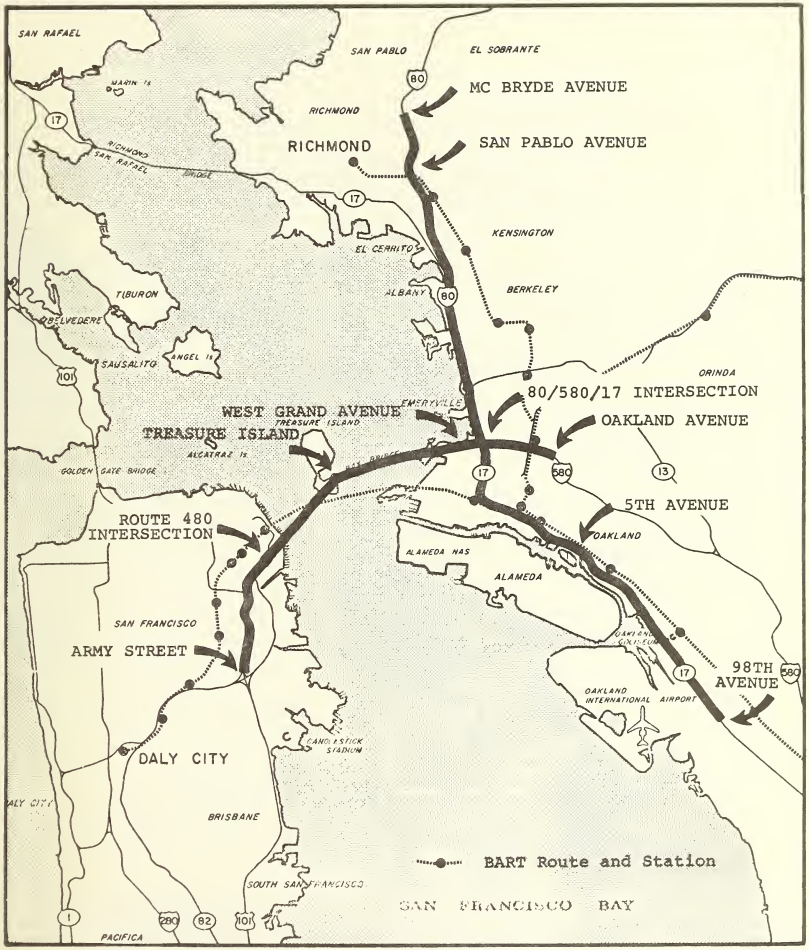

FIGURE IV-3

LOCATION OF TRAVEL TIME SURVEY SEGMENTS

transbay BART" data were collected prior to the institutuion of the 55 mph speed limit in January 1974. As a consequence, many of the "before" data show travel times smaller than form a fair basis for comparison with the "after" data. In order to take this into account (albeit in an approximate way), a plot of the after data, adjusted downwards in the ratio of the old to the new speed limits, is included for comparison where appropriate. Note that Route 101 in San Francisco and the Bay Bridge itself both had speed limits of 50 mph before and after January 1, 1974, and so, are unaffected.

Travel Times on the San Francisco-Oakland Bay Bridge for Morning Peak Period (Westbound) Travel (Figure IV-4). The morning westbound peak period travel times for October 1974 on the Bay Bridge itself, although still showing a marked increase in the period 7 a.m. to 8 a.m. relative to the periods 6 a.m. to 7 a.m. and 8 a.m. to 9 a.m., appear to be significantly less than was the case in April 1974. The April 1974 points were observed after the implementation of the metering system (described in the previous section), so that with due recognition of the small sample of observations involved and possible seasonal effects, the apparent reduction in travel times can be attributed to BART with some degree of confidence. This conclusion reinforces the analysis of the metering system data presented previously.

Travel Times on the Approaches to the San Francisco-Oakland Bay Bridge for Morning Peak Period (Westbound) Travel. For both Route 80 from the north (Figure IV-5) and Route 580 from the southeast (Figure IV-6) leading to the Bay Bridge, there was an apparently large decrease in travel times between the before and after data for the morning peak period. For both highways the before (1972) data show a pronounced peak congestion between 7 a.m. and 8 a.m. (slightly earlier for Route 580). In October 1974, there appears to be negligible congestion. This apparent reduction is more pronounced if the possible effects of the 55 mph limit are taken into account. However, in both cases, the after data consist of only one observation at each time of day so that special caution is required in interpreting the results. Moreover, over two years separate the before and after data, so that it would be foolhardy to attribute the change solely to the introduction of transbay BART.

Figure IV-7 shows that in September 1972, there was apparently very little congestion on Route 17 northbound in the morning peak period and that this situation was unchanged in October 1974. Indeed, if adjustment for the change in the speed limit is made, the before and after situations appear identical.

Travel Times on the Approaches to the San Francisco-Oakland Bay Bridge for Evening Peak Period (Eastbound) Travel. The before transbay BART travel times presented in Figure IV-8 were collected in September and October 1971 for evening peak period travel on Route 101 (Bayshore Freeway) leading to the Bay Bridge from San Francisco. Comparison of these data

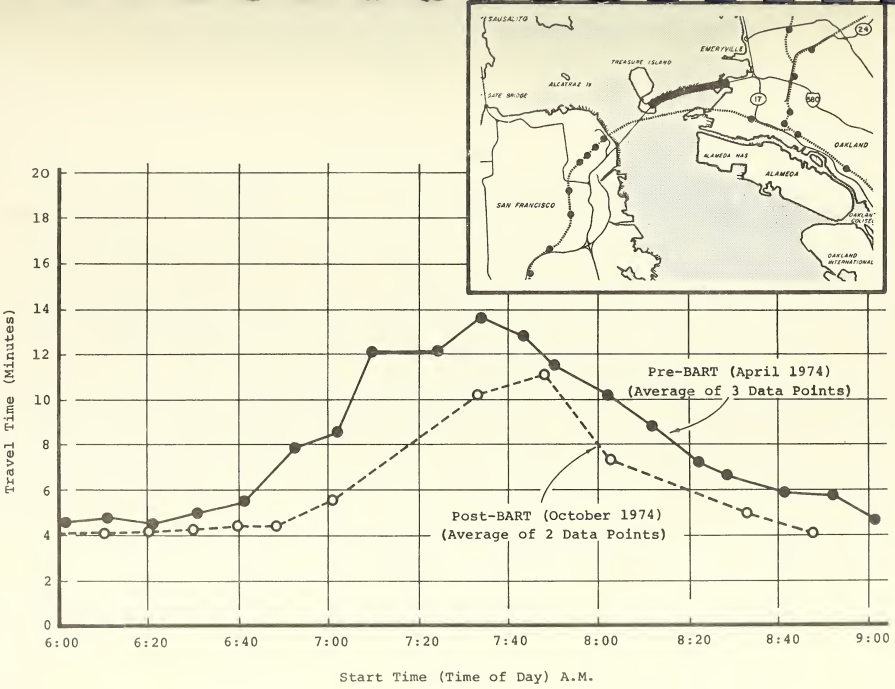

FIGURE IV-4

MORNING PEAK PERIOD (WESTBOUND) TRAVEL TIMES ON SAN FRANCISCO-OAKLAND BAY BRIDGE
W. GRAND AVENUE (OAKLAND) TO TREASURE ISLAND: 3.2 MILES

Source: • CALTRANS, Moving Car Observer Travel Time Surveys

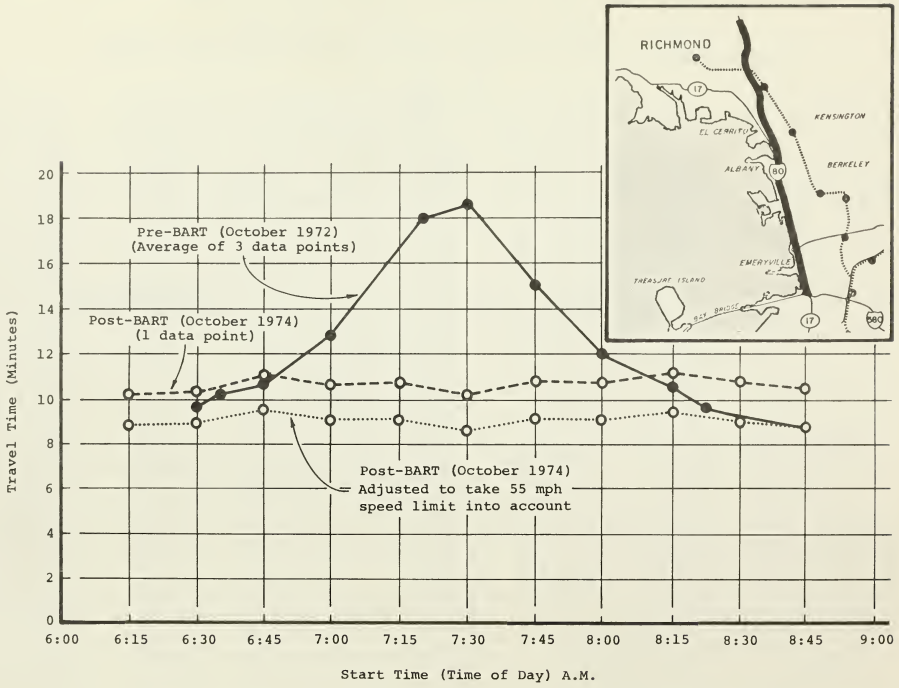

FIGURE IV-5

MORNING PEAK PERIOD (SOUTHBOUND) TRAVEL TIMES ON INTERSTATE ROUTE 80
MC BRYDE AVENUE (RICHMOND) TO DISTRIBUTION STRUCTURE (OAKLAND): 8.8 MILES

Source: CALTRANS, Moving Car Observer Travel Time Surveys.

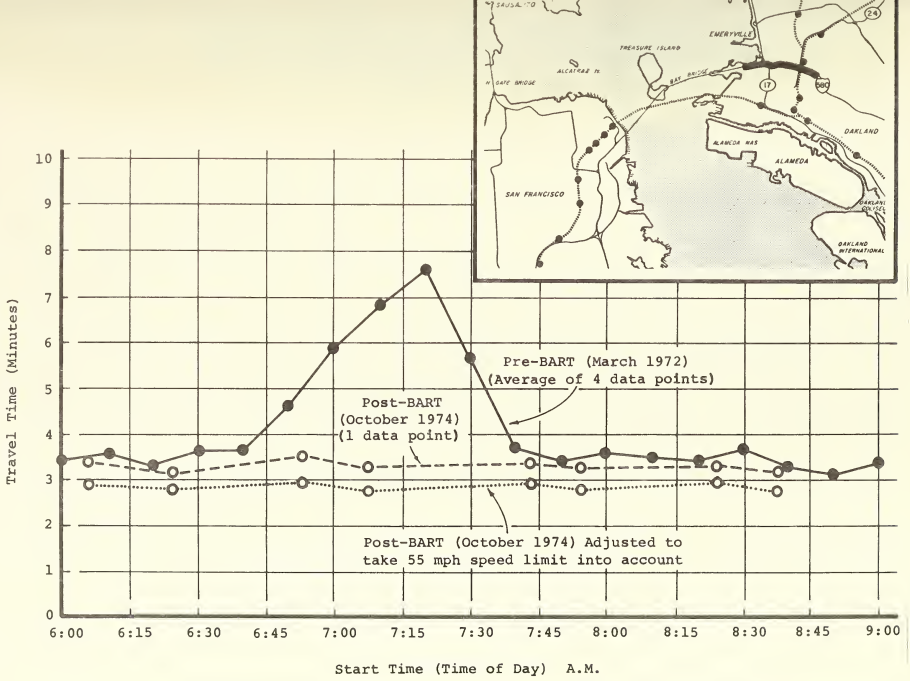

FIGURE IV-6

MORNING PEAK PERIOD (WESTBOUND) TRAVEL TIMES ON INTERSTATE ROUTE 580
OAKLAND AVENUE (OAKLAND) TO W. GRAND AVENUE: 3.0 MILES

Source: • CALTRANS, Moving Car Observer Travel Time Surveys.

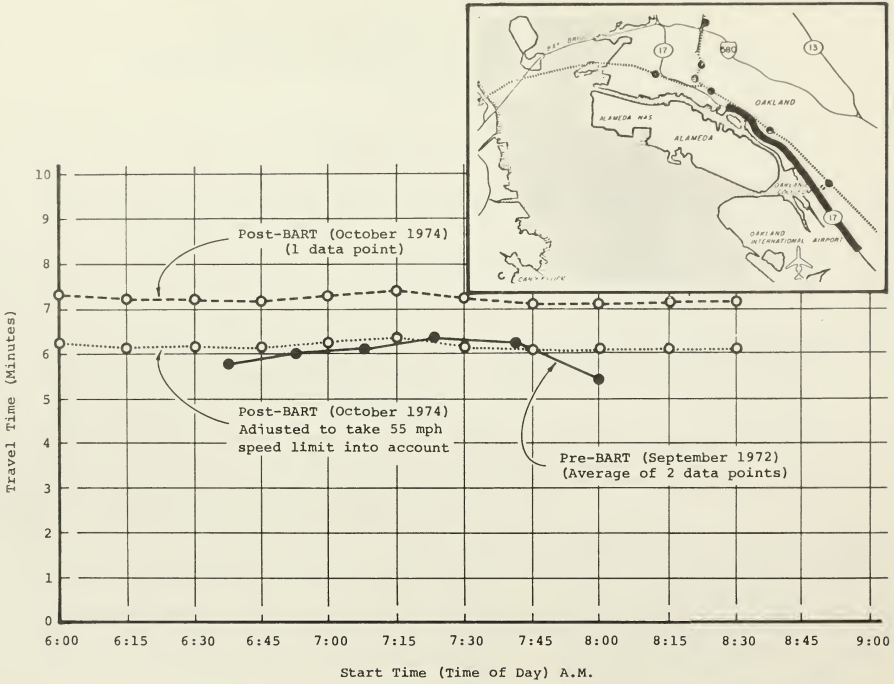

FIGURE IV-7

MORNING PEAK PERIOD (NORTHBOUND) TRAVEL TIMES ON ROUTE 17
98TH AVENUE (OAKLAND) TO 5TH AVENUE (OAKLAND): 5.6 MILES

Source: • CALTRANS, Moving Car Observer Travel Time Surveys

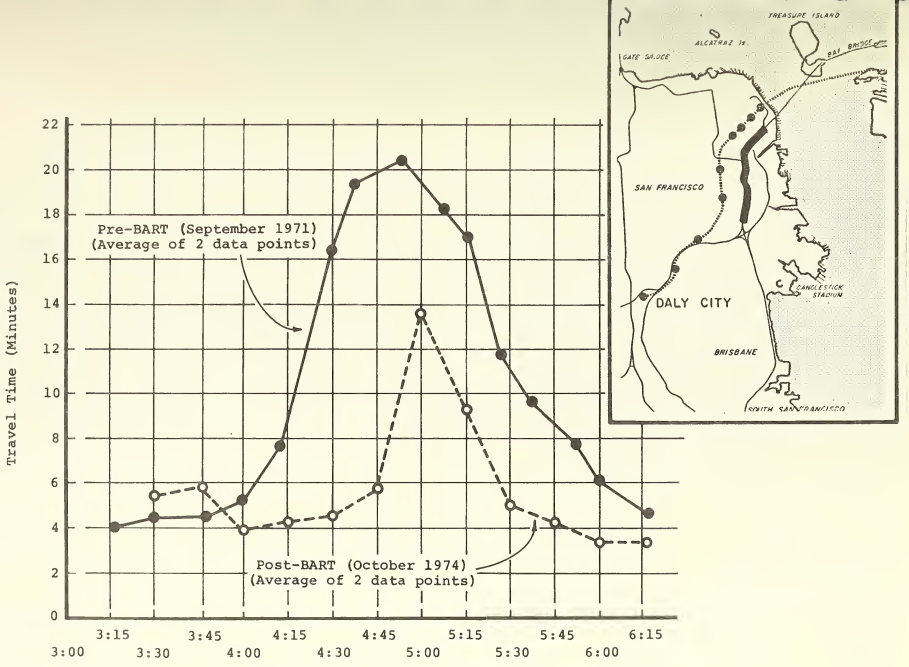

FIGURE IV-8

EVENING PEAK PERIOD (EASTBOUND) TRAVEL TIMES ON ROUTE 101
ARMY STREET (SAN FRANCISCO) TO INTERSECTION OF ROUTES 80 AND 480: 2.6 MILES

Source: • CALTRANS, Moving Car Observer Travel Time Surveys.

with the October 1974 observations shows an apparently marked reduction in both the duration of the peak period and peak travel time. However, the long period intervening between the two sets of observations preclude any confident statement about BART's possible effect on this change.

The distributions for evening peak travel times on Route 80 leading northbound from the Bay Bridge on the East Bay (Figure IV-9) were constructed on the basis of three sets of travel time runs conducted in December 1973 and two sets in October 1974. The small sample sizes available do not allow any statistical test of the differences between the two distributions, but indications are that the differences were small.

Conclusions. The caveat needs to be repeated that the travel time data presented in this section form a very uncertain basis for concluding that there has been a reduction in traffic congestion on the San Francisco-Oakland Bay Bridge or the highways leading to it, let alone ascribing this reduction to BART. Nevertheless, it seems that, at least considering the period immediately after the start of transbay BART service, diversion of travel to BART may have been a significant factor in the apparent reduction in morning peak period traffic congestion on the Bay Bridge and its approaches as described above.

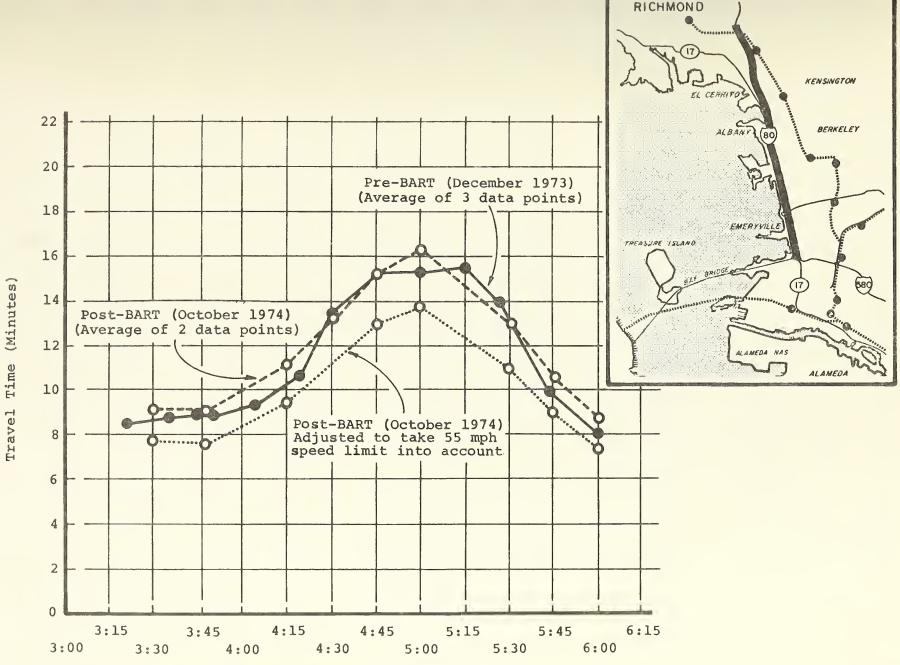

FIGURE IV-9

EVENING PEAK PERIOD (NORTHBOUND) TRAVEL TIMES ON INTERSTATE ROUTE 80
INTERSECTION OF ROUTES 80, 580, AND 17 (OAKLAND) TO SAN PABLO AVENUE: 8.0 MILES

Source: • CALTRANS, Moving Car Observer Travel Time Surveys.

V. DESCRIPTION OF TRANSBAY JOURNEYS

Context for Analysis of Transbay Survey Results

As indicated by the analyses of Chapter III, the pattern of travel across the Bay Bridge changed in the weeks following the start of transbay BART service. Changes over the 14-week period between the start of transbay BART service on September 16 and the middle of December 1974 are shown in Figure V-1.

Increase in Transbay BART Ridership Since the Opening of Transbay BART Service. Over the period since September 16, BART ridership, according to BART's own patronage estimates, increased from about 21,000 westbound transbay trips in the week of September 16, to 26,000 in the week of October 28, and to 29,000 in the week of December 16, 1974.*

Reduction in Transbay Bus Service and Ridership Since the Start of Transbay BART Service. As shown in Figure V-1, there have also been changes in travel by bus over this period. With the start of transbay BART, both AC Transit and Greyhound have gradually reduced transbay bus service. On September 16, AC Transit reduced their "C" route bus service by 12 buses in both the morning and evening. This route had previously formed the "transbay BART" link, carrying about 1,200 daily passengers in each direction between the MacArthur BART station and the Transbay Bus Terminal in San Francisco. Over the period from September 17 to October 30, 1974 (the date of the BART Impact Program surveys of transbay travel), AC Transit withdrew an additional 45 buses from their transbay routes. A further six buses were withdrawn by the end of 1974.

Following the initial diversion from bus to BART after the start of transbay BART service, there was a further reduction in AC Transit's ridership of about 2,000 daily westbound trips by the end of October. From October 30 until the end of the year, ridership dropped by another 700 daily trips.

In total, AC Transit transbay ridership in December 1974 was about 10,000 trips lower, in each direction, than ridership in June 1974 (before the AC Transit strike).

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*BART's estimates of transbay ridership over this whole period are based on a one-day count of transbay ridership conducted by ITTE personnel in October 1974 (see Chapter II). The estimates may, therefore, be in error to the extent that the ratio of transbay trips to total System trips has been different at times before and after the count was taken. The ridership estimate for the week of December 16, 1974, is also inflated, relative to the earlier estimates, by the fact that BART was operating from 6:00 a.m. to 10:00 p.m. at this time but only from 6:00 a.m. to 8:00 p.m. during September and October.

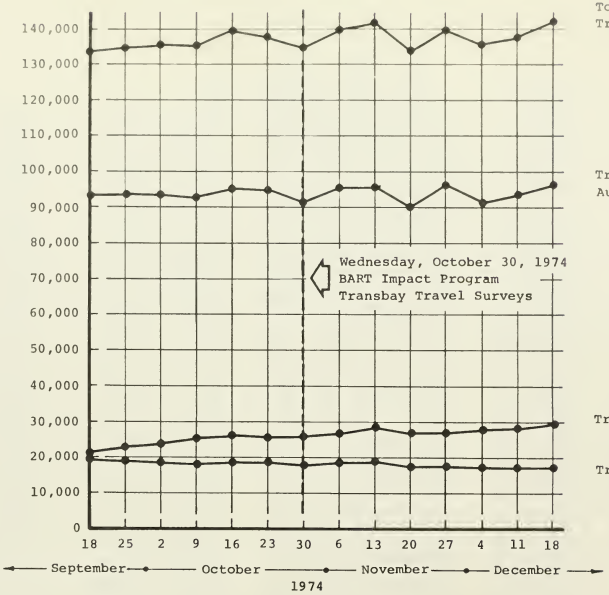

FIGURE V-1

CHANGES IN TRANSBAY MIDWEEK TRAVEL SEPTEMBER - DECEMBER, 1974

* Includes BART trips made between 8:00 p.m. and 10:00 p.m. for the extended hours of service operated during the Christmas shopping period from November 29 to December 27, 1974.

Sources:
- CALTRANS Toll Bridge Administration, Daily Totalizer Volume Counts
- University of California ITTE, October 1974 Bay Bridge Surveys
- BARTD, Daily Patronage Reports
- AC Transit District, Daily Passenger Counts

Greyhound similarly reduced its transbay services from Contra Costa County concurrent with a drop in ridership of about 4,000 daily westbound transbay trips from June 1974 to December 1974. About 1,300 trips of this loss occurred between the initial diversion to BART and the end of October, and another 500 trips were lost by December 1974.

Increase in Transbay Automobile Travel Since the Start of Transbay BART Service. Figure V-1 shows an increase of about 1,000 daily automobile trips from the weekday average for the week of September 16, the week of the start of BART service, to the week of October 14, one month later. Over the whole 14-week period to the middle of December 1974, the increase in automobile travel was about 2,000 daily westbound trips.*

Increase in Total Transbay Travel Since the Start of Transbay BART Service. The sum of the ridership estimates for BART, bus, and automobile travel in the Bay Bridge corridor shows an apparent increase in total travel over the period since BART's opening. In the week following the start of BART service, total westbound travel in the 14 hours from 6:00 a.m. to 8:00 p.m. was about 134,000 trips. By the week of October 28, total travel had increased to 135,000 trips, and by the week of December 16 was at a level of 142,000 trips.

Differences in Transbay Travel by Direction. The surveys of travel by BART, bus, and automobile in the San Francisco-Oakland Bay Bridge corridor described in Chapter II were conducted on Wednesday, October 30, 1974. For this day, total westbound travel in the 14 hours from 6:00 a.m. to 8:00 p.m. was estimated to be 135,600 trips. Of these, 25,400 were made by BART, 18,100 were made by AC Transit and Greyhound bus, and 92,100 were made by private automobile.

The transbay travel surveys showed that, although total daily eastbound and westbound travel in the Bay Bridge corridor was approximately equal, there were some significant differences in directional travel among the three modes. The modal distribution of transbay travel in the 14-hour day is summarized in Table V-1 and shows that passenger travel by automobile was approximately in balance; that eastbound BART travel was slightly greater than westbound travel; and that westbound bus travel was slightly greater than eastbound. The apparent net transfer of 900 trips from bus to BART for the eastbound direction may be explained by the fact that a free transfer is available to BART travelers transferring to AC Transit buses but not AC Transit travelers transferring to BART. Some travelers may have therefore taken the bus for the complete westbound trip to San Francisco and used BART and bus together

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*It should be pointed out, however, that week-to-week variations over the period were such that these indicated changes cannot be taken as representing true increases in automobile trips with any great confidence.

Table V-1

DISTRIBUTION OF TRANSBAY TRIPS[a] BY DIRECTION

Westbound Trip By	Eastbound Trips BART	Bus	Automobile	Total
BART	23,300	600	1,500	25,400
Bus	1,500	15,800	800	18,100
Automobile	1,300	700	90,100	92,100
Total	26,100	17,100	92,400	135,600

a. Numbers are total midweek daily person trips made between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).

Sources: Estimates based on analysis of:

- BART Impact Program October 1974 Surveys of Transbay Travel by BART, bus, and automobile (sample size = 2,000 trips in each case).
- CALTRANS Toll Bridge Administration, Daily Totalizer Volume Counts.
- University of California, ITTE, Bay Bridge Vehicle Classification and Occupancy Surveys.
- AC Transit District, Daily Passenger Counts.
- Greyhound Lines, Inc., Contra Costa County Commute Service Passenger Counts provided to the State of California Public Utilities Commission.

for the eastbound trip. The shift from bus for morning (westbound) travel to BART for evening (eastbound) travel could also be explained by a tendency for travelers to board the nearest mode and not change modes until necessary.

Control Totals for Tabulation of Transbay Travel Descriptions. As shown by Table V-1, total 14-hour eastbound travel at the time of the October 1974 transbay surveys was 26,100 trips by BART, 17,100 trips by AC Transit and Greyhound bus, and 92,400 trips by automobile. Of the automobile trips, 65,200 were made by drivers and 27,200 by passengers. In all tabulations of survey data included in this report, the estimates of eastbound and westbound trips as shown in Table V-1 were used as the control totals.

The discussions of Chapters III and IV concentrated on westbound travel across the Bay bridges because most of the traffic count data have been collected for the westbound direction. In the following sections, eastbound travel is generally used as the basis for analysis since the October 1974 transbay surveys for both BART and bus were conducted for eastbound travel. Where necessary for purposes of comparison among the three surveys, it will be assumed that, over the day as a whole, Bay Bridge automobile trips (which were surveyed in the westbound direction) are symmetric with respect to the characteristics of the trips and the travelers making them.

Context for Interpretation of Transbay Survey Results. In the context of the changing pattern of transbay travel illustrated in Figure V-1, the findings presented in this report must be regarded as "snapshot" pictures of a changing scene. All three on-route surveys were conducted on a single midweek day some six weeks after the start of transbay BART service. The surveys were carefully conducted and analyzed in order to give as accurate a picture as possible of transbay travel between 6:00 a.m. and 8:00 p.m. as it occurred on that day. Moreover, the telephone control survey results and other available evidence give no reason to believe that the day of the survey was unusual in any important respect. Nevertheless, the findings presented must be regarded as describing a situation which may already have changed and which will continue to change particularly with regard to the level of BART service provided.

Purposes of Transbay Travel

Tables V-2 and V-3 show the distribution of transbay trips by mode and purpose. Table V-2 shows the actual number of trips in each category and percentages based on the total number of trips made for each purpose. Table V-3 shows percentages based on the total number of trips made by each mode.

Table V-2

PURPOSE AND MODE OF TRANSBAY TRIPS[a]
(Percentages Based on Total of Trips by All Modes)

Purpose of Travel	Mode of Travel					
	BART	Bus	Automobile	Total All Modes	Automobile Driver	Automobile Passenger
Work to or From Home	17,900 21%	14,700 17%	52,200 62%	84,800 100%	38,500 46%	13,700 16%
Other Work Related Travel[b]	2,600 13%	900 5%	16,300 82%	19,800 100%	13,000 66%	3,300 16%
School or College	2,500 24%	1,000 10%	7,000 66%	10,500 100%	4,600 43%	2,400 23%
Shopping	800 20%	100 3%	2,900 77%	3,800 100%	1,100 28%	1,800 49%
Visiting Friends or Relatives	800 15%	200 4%	4,300 81%	5,300 100%	2,800 53%	1,500 28%
Recreation or Touring[c]	800 23%	100 4%	2,600 73%	3,500 100%	800 23%	1,800 50%
Other Purposes	700 9%	100 1%	7,100 90%	7,900 100%	4,400 56%	2,700 34%
TOTAL - ALL PURPOSES	26,100 19%	17,100 13%	92,400 68%	135,600 100%	65,200 48%	27,200 20%
Work to or From Home	17,900 21%	14,700 17%	52,200 62%	84,800 100%	38,500 46%	13,700 16%
All Other Purposes	8,200 16%	2,400 5%	40,200 79%	50,800 100%	26,700 52%	13,500 27%

a. Frequencies are total midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).
b. Includes non-home oriented work trips and "business calls".
c. Includes "recreation area or facility", "touring", and "BART excursion ride".

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Table V-3

PURPOSE AND MODE OF TRANSBAY TRIPS[a]
(Percentages Based on Total of Trips for All Purposes)

Purpose of Travel	Mode of Travel					
	BART	Bus	Automobile	Total All Modes	Automobile Driver	Automobile Passenger
Work To or From Home	17,900 68%	14,700 86%	52,200 56%	84,800 62%	38,500 59%	13,700 50%
Other Work Related Travel[b]	2,600 10%	900 4%	16,300 18%	19,800 15%	13,000 20%	3,300 12%
School or College	2,500 10%	1,000 6%	7,000 7%	10,500 8%	4,600 7%	2,400 9%
Shopping	800 3%	100 1%	2,900 3%	3,800 3%	1,100 2%	1,800 7%
Visiting Friends or Relatives	800 3%	200 1%	4,300 5%	5,300 4%	2,800 4%	1,500 6%
Recreation or Touring[c]	800 3%	100 1%	2,600 3%	3,500 2%	800 1%	1,800 6%
Other Purposes	700 3%	100 1%	7,100 8%	7,900 6%	4,400 7%	2,700 10%
TOTAL - ALL PURPOSES	26,100 100%	17,100 100%	92,400 100%	135,600 100%	65,200 100%	27,200 100%
Work To or From Home	17,900 68%	14,700 86%	52,200 56%	84,800 62%	38,500 59%	13,700 50%
All Other Purposes	8,200 32%	2,400 14%	40,200 44%	50,800 38%	26,700 41%	13,500 50%

a. Frequencies are total midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).
b. Includes non-home oriented work trips and "business calls".
c. Includes "recreation area or facility", "touring", and "BART excursion ride".

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Comparison of Journey Purposes of Transbay Trips Among Modes. Table V-2 shows the clear predominance of automobile travel in the transbay travel picture. A total of about 135,600 daytime trips were made by automobile, bus, and BART each weekday in the Bay Bridge corridor. Of these, 68% were made by automobile, 13% by bus, and 19% by BART.

Also clear from Table V-2 is the predominance of work journeys in transbay travel. About 84,800 trips, or 62% of the total, were to or from home and a further 19,800, or 15% were for other work-related purposes. The automobile accounted for most (62%) of the work journeys to or from home, but the importance of transit, and particularly BART, is also apparent; 21% of journeys between home and work were made by BART and the remaining 17% by bus. These numbers contrast with the modal split for travel other than the journey between home and work. Of the total of 50,800 transbay trips made for "all other purposes," 79% were made by automobile, 16% by BART, and only 5% by bus.

Table V-3 shows that of all transbay trips made by automobile, 56% were to or from work and another 18% for other work-related travel. Of all trips made by bus, 86% were to or from work and another 4% for other work-related travel. Of transbay BART trips, 68% were to or from work and 10% for other work-related purposes. Thus, BART's transbay riders were primarily making the journey to or from work, although to a lesser extent than on bus; of the 26,100 daily trips on BART, 22% were for nonwork purposes compared to only 10% for bus.

Next to work journeys in importance were trips to or from school or college. These made up 10% of BART transbay ridership. The remaining transbay BART trips were evenly split among the shopping, visiting, touring, and "other" categories (3% of BART ridership in each case).

In the perspective of all transbay trips being made for nonwork purposes, BART's nonwork ridership appears more significant. For example, BART carried 24% of all journeys being made across the Bay to or from school or college (compared to 10% on bus) and 20% of transbay shopping trips (compared to 3% for bus).

Comparison of Journey Purposes of Transbay BART Trips With Other BART Trips. In May 1974, when all lines of the BART system were in operation with the exception of the transbay link, a full survey of BART travelers was conducted.* Results of the May 1974 survey show that for travel within San Francisco, 77% of trips were made for work purposes and 23% for nonwork purposes. For BART travel on the East Bay,** 70% of trips were

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*See notes to Table VI-3 on page 88 for a description of the May 1974 BART Passenger Profile Survey.

**Inclusive of approximately 1,200 trips made transbay by transferring from BART to AC Transit buses at MacArthur Station.

made for work purposes and 30% for nonwork purposes. The corresponding percentages derived from the October 1974 survey for transbay travel were 78% work and 22% nonwork, indicating that transbay BART travel is more work-oriented than other BART travel, although not significantly so compared with travel within San Francisco.

Distribution of Transbay Journeys by Time of Day and Direction

As reflected by the analyses of aggregate travel in the San Francisco-Oakland Bay Bridge corridor discussed in the two preceding chapters, transbay travel by all modes varied considerably by time of day and by direction of travel.

Distribution of Transbay BART Travel by Time of Day and Direction. Consistent with the mainly work-oriented nature of BART travel across the Bay, most of BART's ridership was concentrated in the peak periods. Thus, for eastbound travel, about 53% of BART's 14-hour day ridership occurred in the three hours from 3:00 p.m. to 6:00 p.m. By contrast, only 6% of all daily eastbound ridership occurred in the morning three-hour period from 6:00 a.m. to 9:00 a.m. This reflects the predominant pattern of journeys to work in San Francisco from the residential suburbs on the East Bay, returning to the East Bay in the evening. Relatively few transbay BART riders were making the reverse journey. Over the whole day, about 15,600 trips were made to the East Bay from work in San Francisco (87% of trips between work and home); only about 2,300 trips (13%) were made from San Francisco to work in the East Bay.

Distribution of Transbay Bus Travel by Time of Day and Direction. By comparison, 70% of eastbound bus travel occurred in the evening peak period from 3:00 p.m. to 6:00 p.m. and 5% in the morning peak period from 6:00 a.m. to 9:00 a.m., reflecting an even heavier work journey orientation than BART. Travel was also very heavily San Francisco work place-oriented. Over the day, about 14,300 eastbound trips were made by bus from work places in San Francisco (97% of trips between work and home); only about 400 trips (3%) were made by bus to work places in the East Bay by people living in San Francisco.

Distribution of Transbay Automobile Travel by Time of Day and Direction. Reflecting the lower proportion of work journeys in the total, automobile travel across the Bay Bridge showed a much more even distribution of travel over the day. About 80% of 24-hour eastbound traffic on the Bay Bridge occurred between 6:00 a.m. and 8:00 p.m. About 16% of this daytime traffic occurred between 6:00 a.m. and 9:00 a.m., and 32% between 3:00 p.m. and 6:00 p.m.* Relative to both BART and bus travel, work journeys by automobile were also

*It should be emphasized that these figures are for total vehicle traffic. Comparisons with the ridership figures given above for BART and bus should recognize that private automobiles made up a higher proportion of total vehicles during the peak period than at other times of day.

much more evenly distributed between East Bay and San Francisco work locations. Of the total of 52,200 transbay automobile trips made between home and work during the 14-hour day 6:00 a.m. to 8:00 p.m., 36,900 trips (71%) were made from home in the East Bay to work places in San Francisco; 15,300 trips (29%) were made from home in San Francisco to work places in the East Bay. Considering eastbound transbay travel by all modes combined, 84,800 trips a day were made between home and work. Of these, 66,800 trips (79%) were made to work places in San Francisco and 18,000 trips (21%) were made to work places on the East Bay.

Transbay "Reverse Commute" Journeys. The above figures show that BART was used by people making the transbay "reverse commute" journey to work in the East Bay from home in San Francisco to a considerably greater extent than was bus (2,300 trips on BART compared to 400 trips a day on bus). However, the automobile still carried the great majority of such trips (15,300 trips a day, or 85% of all reverse commute trips).

Origin-Destination Patterns of Transbay Journeys

Tables B-1 through B-4 in Appendix B show origin-destination patterns of transbay travel for, respectively, BART, bus, automobile, and all three modes combined. Tables B-5 through B-8 show corresponding origin-destination matrices for transbay work journeys.

Origin-Destination Patterns of Transbay BART Trips. The origin-destination matrix of BART trips clearly illustrates the marked orientation of travel toward downtown San Francisco locations; 17,300 trips or 66% of all transbay BART trips were made to or from the San Francisco downtown and San Francisco Civic Center zones (Zones 2 and 3).* As might be expected, this emphasis is even clearer for work travel; 13,900 daily trips, or 76% of total transbay work trips, were made to these two central San Francisco zones.

Within the East Bay, the Berkeley zone, which contains the North Berkeley, Berkeley, and Ashby Stations, was the destination for the largest number of transbay trips (3,600 trips per day of which about 1,200 were school trips to the University of California [Berkeley] BART station). The two zones to the north of the Berkeley zone on the Richmond BART Line, Albany (Zone 29) and Richmond (Zone 28), which together contain three BART stations, accounted for only an additional 1,500 trips (6% of the total).

The three eastern Contra Costa County zones of Concord (Zone 26), Walnut Creek (Zone 25), and Orinda-Lafayette (Zone 24), which together contain

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*The definitions of the zones used in this analysis are shown in the map of Figure B-1 and Table B-9.

five BART stations, accounted for 3,600 trips, 3,100 trips, and 2,600 trips per day, respectively. These three zones together made up 36% of all transbay trips.

Fremont (Zone 19), Hayward (Zone 20), San Leandro (Zone 21), and South Oakland (Zone 22), which contain the eight Fremont Line BART stations, together accounted for 4,300 trips (16% of the total).

Aside from the marked differences in the proportions of total travel to the areas of the East Bay served by the three BART lines, it is interesting to note the extent to which the orientation of travel from work places on the West Bay differed. The three Concord Line zones (24, 25, and 26) accounted for 8,200 transbay work trips; of these, 7,300 trips (89%) were trips from work places in the San Francisco central business district (Zones 2 and 3). The four Fremont Line zones (19, 20, 21, and 22) accounted for 3,500 transbay work trips, of which 2,600 (74%) were downtown San Francisco trips. Transbay travel from the Richmond Line was less downtown San Francisco-oriented. A total of 2,200 transbay trips were made to the Richmond-El Cerrito, Albany, and Berkeley zones (28, 29, and 30); 1,400 of these (64%) were work trips from the two central San Francisco zones.

Origin-Destination Patterns of Transbay Bus Trips. The orientation of trips to downtown San Francisco work places was even more evident for transbay bus travel than for BART, reflecting the fact that all transbay commuter buses terminate at the Transbay Bus Terminal in downtown San Francisco. As shown in Tables B-2 and B-6, 12,300 daily transbay bus trips, or 72% of the total, originated in the two central San Francisco zones; for work trips, 11,800 (78% of transbay bus work-trips) originated in these two downtown San Francisco zones.

However, the pattern of destination for bus trips on the East Bay was understandably rather different from that for BART, reflecting the relative accessibility provided by bus and BART. The zones to which most eastbound transbay bus trips were destined are the Berkeley, Albany, and Richmond-El Cerrito zones (28, 29, and 30), which together accounted for 6,000 transbay trips (35% of the total). Piedmont and Alameda (Zones 32 and 33) accounted for 2,900 trips (17%). Relatively few bus trips were made to the southern Alameda County zones. The Fremont, Hayward, San Leandro, and South Oakland zones (19, 20, 21, and 22) together accounted for 2,200 transbay bus trips (13%).* It is also noteworthy that at the time of the survey,

*At the time of the survey, no bus transit service was available to the Pleasanton-Livermore area. On December 2, 1974, "BART express bus" services started to the Hayward and Bay Fair BART stations from Dublin, San Ramon, Pleasanton, and Livermore. On the same date, BART express bus services connecting to the El Cerrito Del Norte, Concord, and Walnut Creek BART stations were also started from the north, east, and south, respectively.

some 2,700 transbay bus trips, or 16% of the total, were made by Greyhound bus to the Orinda-Lafayette, Walnut Creek, and Concord zones (24, 25, and 26).

Origin-Destination Patterns of Transbay Automobile Trips. Transbay automobile travel was also largely oriented toward downtown San Francisco locations, but to a much lesser extent than the two transit modes. About 30,800 trips (33% of the total) were made to the two central-city San Francisco zones (2 and 3). A further 24,500 trips (27% of the total) were made to the four adjacent zones in San Francisco to the north and west of the central business district (Zones 4, 5, 6, and 7). BART serves only the southern edge of this area. A significant number of transbay automobile trips (5,300 trips or 6% of the total) were also made to the South San Francisco zone (13) which contains San Francisco International Airport.

Within the East Bay, the distribution of automobile transbay trip origins among the zones is generally unremarkable. Worthy of note is the fact that a large number of transbay trips were made by automobile from the three eastern Contra Costa County zones of Concord, Walnut Creek, and Orinda-Lafayette (19,100 trips, or 21% of all transbay automobile trips). At the time of the survey, these zones were served by both Greyhound bus and BART.

Modal Split of Downtown San Francisco Trips. It has already been noted that the distribution of all transbay travel (135,600 trips per day eastbound) was 19% BART, 13% bus, and 68% automobile. However, this modal split varied considerably for different origin-destination zone interchanges. For example, for the total 60,500 trips to or from central San Francisco (Zones 2 and 3), the distribution among modes was: 29% BART, 20% bus, and 51% automobile. This again reflects the greater role played by transit in downtown journey-to-work travel.

Trip Times. Reflecting the origin-destination patterns of travel discussed above (as well as the level of service provided by the alternative modes), transbay journeys by BART were longer in terms of travel time than those made by bus or automobile. The median door-to-door travel time of all trips made on BART transbay was 58 minutes, on bus 48 minutes, and by automobile 35 minutes.

BART's Share of Transbay Journeys

The zone-to-zone pattern of transbay travel discussed in the previous section is reinforced by the pattern of travel between BART stations shown in Table V-4 (for San Francisco stations) and Table V-5 (for East Bay stations). Table V-6 shows the origin-to-destination pattern of transbay BART travel summarized by groups of stations.

In Tables V-4 and V-5, transbay trips by bus and automobile have been assigned to BART stations based on which station the travelers said they would

Table V-4

DISTRIBUTION OF TRANSBAY TRAVEL BY MODE
BY SAN FRANCISCO BART STATION

San Francisco BART Station	Daily Transbay Trips 6:00 a.m.-8:00 p.m. Percentage Distribution By BART	Bus[a]	Automobile[a]	Total Trips[b]
Montgomery Street[c]	18%	20%	62%	72,500
Powell Street	31	7	62	17,600
Civic Center	24	7	69	17,700
Subtotal-Downtown Stations	21%	15%	64%	107,800
16th Street - Mission	13	4	83	4,700
24th Street - Mission	17	1	82	4,600
Subtotal - Mission Stations	15%	3%	82%	9,300
Glen Park	20	1	79	2,500
Balboa Park	19	3	78	3,400
Daly City	9	1	90	12,600
Subtotal - Outer Stations	12%	1%	87%	18,500
TOTAL - ALL STATIONS	19%	13%	68%	135,600

a. Numbers are total midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).

b. The distribution of bus and automobile trips among BART stations is made on the basis of the station which survey respondents said they would use if they were to travel by BART (whether or not BART is actually regarded by them as a feasible alternative).

c. For example, of the 72,500 transbay trips which are being or could be served by the Montgomery Street BART Station, the actual modal distribution was BART 18%, bus 20%, and automobile 62%.

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

Table V-5

DISTRIBUTION OF TRANSBAY TRAVEL BY MODE
BY EAST BAY BART STATION

East Bay BART Stations	Daily Transbay Trips 6:00 a.m.-8:00 p.m. Percentage Distribution By BART	Bus[a]	Automobile[a]	Total Trips[b]
Concord	32%	3%	65%	7,400
Pleasant Hill	31	11	58	7,500
Walnut Creek	19	13	68	10,800
Lafayette	26	7	67	6,400
Orinda	28	4	68	5,700
Rockridge	16	17	67	8,600
Subtotal - Concord Line Stations	25%	10%	65%	46,400
Richmond	4	8	88	4,200
El Cerrito del Norte	17	27	56	3,600
El Cerrito Plaza	8	19	73	5,700
North Berkeley	8	17	75	5,900
Berkeley	19	16	65	13,900
Ashby	12	9	79	2,700
Subtotal - Richmond Line Stations	13%	16%	71%	36,000
Fremont	46	1	53	2,000
Union City	48	4	48	1,300
South Hayward	45	26	29	700
Hayward	24	7	69	3,400
Bay Fair	24	14	62	2,600
San Leandro	20	18	62	3,800
Coliseum	13	11	76	4,000
Fruitvale	10	16	74	8,300
Subtotal - Fremont Line Stations	21%	13%	66%	26,100
Lake Merritt	15	8	77	4,700
MacArthur	11	18	71	8,700
Oakland 19th Street	21	12	67	5,200
Oakland 12th Street	20	8	72	7,000
Oakland West	26	4	70	1,400
Subtotal - Oakland Stations	17%	12%	71%	27,100
TOTAL - ALL STATIONS	19%	13%	68%	135,600

a. Numbers are total midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).
b. The distribution of bus and automobile trips among BART stations is made on the basis of the station which survey respondents said they would use if they were to travel by BART (whether or not BART is actually regarded by them as a feasible alternative).

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

Table V-6

ORIGINS AND DESTINATIONS OF TRANSBAY BART TRIPS[a]

Between[b]	Oakland (5 Stations)	Richmond Line (6 Stations)	Concord Line (6 Stations)	Fremont Line (8 Stations)	Total East Bay (25 Stations)
San Francisco Downtown (3 Stations)	13%	13%	42%	18%	86%
San Francisco Mission (2 Stations)	1	2	1	1	5
San Francisco Outer (3 Stations)	3	3	1	2	9
Total San Francisco (8 Stations)	17%	18%	44%	21%	100% (135,600 trips)

a. Total midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).
b. Stations are grouped as shown in Tables V-4 and V-5.

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

use if they were to use BART.* Tabulation of the data in this way allows an assessment of the share of the transbay travel "market" which BART, bus, and automobile carry on a BART station "catchment area" basis.

BART's Share of Transbay Journeys for San Francisco Stations. As shown in Table V-4, BART's share of transbay travel was predictably, highest in the central-city station areas. BART trips accounted for 18% of trips in the Montgomery Street Station catchment area, 31% of potential Powell Street Station trips, and 24% of potential Civic Center Station trips. It is interesting that in the Montgomery Street Station area, bus trips made up a slightly higher proportion of total transbay trips (20%) than BART (18%), reflecting the location of the Transbay Bus Terminal. The proportion of trips carried by transbay bus fell off quickly with distance from the bus terminal because of the need to transfer to a MUNI bus or streetcar for travel to the outer areas. Only 1% of transbay trips from the Glen Park, Balboa Park, and Daly City BART station catchment areas were made by bus.

BART's share of the transbay trip market also fell off with distance from downtown San Francisco, although BART still accounted for a significant part of all transbay trips in the catchment areas of 16th Street- and 24th Street-Mission Stations (15%) and in the catchment areas of the three outer stations (12%). BART's share in the Daly City catchment area was particularly low (9%), reflecting the relatively large number of automobiles from the San Francisco Peninsula (11,400 trips) for which Daly City, as the "end of the line," would have been the BART station used.

BART's Share of Transbay Journeys for East Bay Stations. Table V-5 shows that BART's share of total transbay travel was highest for the catchment areas of the six stations on the Concord Line; 25% of all trips were made by BART. Second highest were the eight stations of the Fremont Line (21%); third, the five Oakland stations (17%); and lowest, the six stations of the Richmond Line (13%).

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*The distribution of bus and automobile trips among BART stations was derived from the responses of travelers who were able to identify the station or stations they would use. For respondents to the bus survey, 94% were able to name a specific East Bay BART station which they would use, and the same proportion, 94%, named a specific San Francisco station. These percentages indicate a high level of familiarity with the BART System (which is consistent with the fact that 58% of current transbay bus travelers have tried BART for their transbay trip).

The proportion of automobile survey respondents who could name the BART stations they would use was somewhat lower than for bus. Ninety percent named an East Bay station, and 81% a San Francisco station. This lower level of familiarity with the BART System is consistent with the fact that only 27% of Bay Bridge automobile travelers have tried BART for their transbay trip.

Reasons for Variations in BART's Share of Transbay Journeys Among East Bay Stations. Variations among the station areas in the distribution of transbay trips by BART, bus, and automobile clearly depend on a large number of factors. Included in these are:

1. The distance involved in traveling between the area and the other side of the Bay.

2. The purposes of the trips being made.

3. The characteristics of travelers, especially automobile ownership, as they affect modal choice.

4. The availability and proximity of BART and line-haul bus transit services.

5. The availability of feeder bus services to BART.

6. The availability of car parking space at the BART station.

7. The characteristics of BART service provided, such as the crowding of trains and whether or not a transfer between BART lines is required.

8. The level of service provided by the competing modes, both bus and automobile.

The present analysis does not allow a full explanation of the differences between the numbers given in Tables V-4 and V-5 in terms of all eight factors. However, some explanations can be speculated upon.

BART's Share of Transbay Journeys for Concord Line Stations. Among the Concord Line stations, BART had the highest share of trips for Concord itself (32%), followed by Pleasant Hill (31%), Orinda (28%), and Lafayette (26%). The percentages for Walnut Creek (19%) and Rockridge (16%) reflected a higher usage of bus--Greyhound in the case of Walnut Creek and AC Transit in the case of Rockridge. Driving from east of the Berkeley Hills to San Francisco involves a long trip through the Caldecott Tunnel and over the Bay Bridge, which is especially trying during the rush hours. It might be expected, therefore, that BART would attract a higher proportion of Concord Line travelers from their cars than the 25% share shown in Table V-5. For work travel, BART's share was appreciably higher, but nevertheless large numbers of commuters continued to drive.* This reflects a number of factors.

*For example, study of the origin-destination matrices given in Appendix B shows that for work journeys from the Concord Line (Zones 24, 25, and 26) to central San Francisco (Zones 2 and 3), BART's ridership was proportionately slightly higher than the estimates shown in Table V-5 for all trip purposes. For work trips made between these two groups of zones the modal split was: BART 42%, bus 14%, and automobile 44%.

In the first place, the figures reflect the fact that BART is operating near the passenger-carrying capacity which can be provided by its currently available stock of cars during the peak periods. At the time of the October 1974 transbay surveys, the total System's car availability was about 85 "A" cars and 130 "B" cars. Of these, about 70 cars (run in 10 trains at 12-minute intervals) typically left Concord for San Francisco during the 7:00 a.m. to 9:00 a.m. morning peak period.* Over this whole two-hour period, load factors typically averaged between 1.5 and 2.0 (i.e., as many standing passengers as seated), with occasional trains approaching load factors of 3.0.**

A second "capacity constraint" on BART ridership on the Concord Line was imposed by the availability of access to the stations. The automobile provides essentially the only means of access for those who are beyond walking distance of Concord Line BART stations in Contra Costa County.*** However, the capacity of BART station parking lots currently limits the number of people who can "park-and-ride." As shown in Table V-7, the five Concord Line stations east of the Berkeley Hills have parking spaces for 5,400 vehicles, virtually all of which are taken by 9:00 a.m. (and generally much earlier).

This evidence suggests that capacity limitations with regard to (1) the current availability of rolling stock, and (2) station car-parking space, together have a significant constraining effect on BART's ridership on the Concord Line.

BART's Share of Transbay Journeys for Fremont Line Stations.

Table V-5 shows that BART's share of trips from the station catchment areas at the southern area of the Fremont Line was high (Fremont 45% and Union City 48%), albeit the total number of transbay trips was fairly small. This reflects (1) the fact that AC Transit buses did not serve the area south of the

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*Source: BARTD Office of Research Memorandum, dated October 9, 1974. Both "A" and "B" cars have a seating capacity of 72 passengers. A minimum of 2 "A" (end-of-train) cars are required to form a train, with up to 7 "B" (middle-of-train) cars coupled between them for current operations.

**These load factors are for MacArthur Station. Load factors at points further up-line are correspondingly lower. Bearing in mind that these are averages over a train which may be as long as 9 cars, they represent considerably higher loading levels than many travelers may find acceptable, especially for a journey of as long as 40 minutes (the scheduled BART journey time from Concord to Montgomery Street). In this regard, it is noteworthy that BART's share of travel is appreciably higher from Concord (where seats are available on originating trains) than at the stations further down the line.

***The Concord Line has the lowest density residential development of all BART corridors; thus, virtually everyone is "beyond walking distance" and auto-dependent. Bus is given as the mode of access to the five Concord Line stations in Contra Costa County for 600 trips or well under 1% of the total. These represent trips using either Greyhound bus or the shuttle bus services provided by the City of Walnut Creek and Rossmoor Leisure World.

Table V-7

UTILIZATION OF BART STATION AUTOMOBILE PARKING LOTS AT 9:00 A.M.

BART Station	Parking Capacity	Utilization Before Transbay BART[a]	Utilization After Transbay BART[b]
Concord	1,350	66%	100%
Pleasant Hill	1,337	58	100
Walnut Creek	1,114	94	100
Lafayette	650	95	100
Orinda	939	64	90
Rockridge	776	16	82
Richmond	784	25%	35%
El Cerrito del Norte	985	60	83
El Cerrito Plaza	509	20	83
North Berkeley	500	24	48
Ashby	560	17	28
Fremont	700	99%	100%
Union City	477	92	100
South Hayward	504	82	100
Hayward	696	69	90
Bay Fair	1,408	34	80
San Leandro	1,106	24	39
Coliseum	923	7	10
Fruitvale	730	41	70
Lake Merritt	339	65%	88%
MacArthur	487	20	48
Oakland West	391	--[c]	20
Daly City	820	100%	100%
Total	18,085		

a. Before transbay BART utilizations are derived from the average of counts taken on Wednesday, September 4, 1974 and Wednesday, September 11, 1974.

b. After transbay BART utilizations are derived from the average of counts taken on Wednesday, October 30, 1974 and Wednesday, November 6, 1974.

c. Station not open.

South Hayward BART Station at the time of the survey, and (2) the alternative of a long automobile drive to the other side of the Bay. BART's share of transbay trips from South Hayward was also high (45%) in spite of the fact that AC Transit transbay bus service is available from the area and accounted for 26% of trips. However, the total number of trips involved was very small.

BART's share of transbay trips became less (and the bus share greater) the closer the stations were to Oakland. This reflects the ability of the bus system to provide relatively better service over the larger areas involved.

Table V-7 shows that the automobile parking lots at all five southernmost stations on the Fremont Line (with a combined parking capacity of 3,800 spaces) were essentially full by 9:00 a.m. As with the Concord Line, this suggests a capacity constraint on the use of BART by potential park-and-ride trip makers.

BART's Share of Transbay Journeys for Richmond Line Stations. Relative to either the Concord or Fremont Lines, BART's share of the transbay trips from the catchment areas of the Richmond Line stations was low, averaging 9% for the Richmond, El Cerrito del Norte, El Cerrito Plaza, and North Berkeley Stations combined. The corresponding bus share of trips from these station areas was 18%, with automobile accounting for the remaining 73%. For the Berkeley and Ashby Station areas, BART's share was slightly higher (18%) than bus (15%), with automobile accounting for 67%.

Table V-7 shows that the utilization of the parking lots at BART stations on the Richmond Line was relatively low, especially at Richmond itself; plenty of spaces were generally still available at the end of the morning peak period. The Richmond Line stations were also generally well served by AC Transit buses.

However, at this time, BART was not operating trains directly from the Richmond Line to San Francisco, requiring transbay passengers to change trains either at the MacArthur Station onto Concord Line trains or at the Lake Merritt Station onto Fremont Line trains. In either case, the then current availability of BART cars meant that this involved a transfer onto an already-crowded train. It is likely that this presented a significant deterrent to BART ridership for transbay travelers from northern Contra Costa County.

Modes of Access To and From BART

Table V-8 shows the distribution of transbay trips according to the mode used to access BART in San Francisco. The table shows both the actual distribution among modes for current BART travelers and the hypothetical modes which current bus and automobile travelers say they would use if they were to ride BART. Table V-9 shows the equivalent pattern of BART access for the East Bay. BART access modes are shown for BART journeys between work and home, and for all other purposes, as well as for the total of all trips.

Table V-8

BART ACCESS MODES FOR TRANSBAY TRAVEL (SAN FRANCISCO)

	Actual BART Access Mode for			Hypothetical BART Access Mode for[a]	
	BART Trips Between Work and Home[b]	BART Trips for Other Purposes[c]	Total Current BART Trips	Total Current Bus Trips	Total Current Automobile Trips
Walk	84%	60%	77%	75%	42%
Bus	7	19	10	20	36
Streetcar	1	7	3	1	3
Drive Car[d]	4	6	5	2	8
Car drop-off/pick-up	3	6	4	1	3
Other Modes[e]	1	2	1	1	8
Total	100%	100%	100%	100%	100%
Actual Number of Trips[f]	17,900	8,200	26,100	17,100	92,400
Median Access Time (minutes)	5	7	6	8	11

a. Mode which would be used by current transbay bus and automobile travelers if they were to use BART for their transbay trip.
b. Trips made for work purposes and made either to or from home.
c. All other trip purposes including non-home based work trips.
d. "Drove car alone" or "Car pool (either driver or passenger)".
e. Includes taxi, motorcycle and bicycle.
f. Midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

Table V-9

BART ACCESS MODES FOR TRANSBAY TRAVEL (EAST BAY)

	Actual BART Access Mode for			Hypothetical BART Access Mode for[a]	
	BART Trips Between Work and Home[b]	BART Trips for Other Purposes[c]	Total Current BART Trips	Total Current Bus Trips	Total Current Automobile Trips
Walk	15%	37%	22%	26%	18%
Bus	13	20	16	34	20
Drive Car[d]	54	34	47	28	51
Car drop-off/pick-up	15	8	13	11	8
Other Modes[e]	3	1	2	1	3
Total	100%	100%	100%	100%	100%
Actual Number of Trips[f]	17,900	8,200	26,100	17,100	92,400
Median Access Time (minutes)	8	7	8	11	9

a. Mode which would be used by current transbay bus and automobile travelers if they were to use BART for their transbay trip.
b. Trips made for work purposes and made either to or from home.
c. All other trip purposes including non-home based work trips.
d. "Drove car alone" or "Car pool (either driver or passenger)".
e. Includes taxi, motorcycle and bicycle.
f. Midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

San Francisco Access Modes to BART. Table V-8 illustrates the small extent to which vehicular modes were used to access BART in San Francisco. Walking was the method of access to BART for 77% of all transbay trips made. The percentage is higher (84%) for journeys to or from work, and if only trips made from work places in San Francisco to residences in the East Bay are considered, the figure is 94%. For all trips, the median access time to BART was six minutes. It is, however, noteworthy that for trips made for purposes other than traveling between home and work about 2,100 transbay trips (19%) used MUNI bus or streetcar to get to BART.

For those travelers who continued to use transbay bus, the hypothetical distribution among access modes to BART was similar to the actual distribution for BART riders, although the percentage of those who would use bus or streetcar is somewhat higher, 21%, compared to 13% for current BART trips. For those travelers who continued to drive, the hypothetical BART trip would, overall, involve much longer access journeys; 30% requiring a bus or streetcar journey and a further 19% some other vehicular mode. However, 42% (38,600 trips) considered they could walk to BART at the San Francisco end of their trip. This, on the face of it, implies a considerable market segment of potential BART riders.

East Bay Access Modes to BART. Table V-9 shows the current importance of the automobile as the mode of access to BART on the East Bay--60% of all transbay trips used automobiles to get to BART stations. (For journeys to and from work the figure was 69%, and for journeys to work in San Francisco from home in the East Bay even higher, at 78%.) The distribution among access modes for the hypothetical BART trips of transbay bus and automobile travelers was similar to the distribution for BART trips. The most significant difference among the three is that bus riders could, understandably, use bus as a feeder to BART more readily than transbay BART and automobile travelers.

Variation in Mode of Access Among East Bay BART Stations. The BART access mode distribution shown in Table V-9 conceals the large variation among the different stations on the East Bay. This is illustrated in Table V-10.

Confirming the analyses of earlier sections, Table V-10 shows how the automobile was the predominant mode of access at the extremities of the East Bay BART lines, especially on the Concord Line. Bus was a more important feeder mode in the more densely urbanized areas, and walking was the most important access mode in the central cities of Oakland and Berkeley. Thus, the percentage of trips using the automobile for access to BART varied from over 90% in Concord, Walnut Creek, and Orinda to less than 10% in downtown Oakland and Berkeley. Conversely, walking was the predominant access mode to the Berkeley, Lake Merritt, 19th Street, and 12th Street Oakland BART stations.

Table V-10

ACCESS MODES FOR TRANSBAY BART TRIPS--EAST BAY BART STATIONS

BART Station	Mode of Access From BART Walk	Bus	Automobile[a]	Total Actual Number of Trips[b]
Concord	5%	1%	94%	2,340
Pleasant Hill	13	--	87	2,360
Walnut Creek	6	2	92	2,080
Lafayette	13	--	87	1,690
Orinda	4	--	96	1,610
Rockridge	35	15	50	1,380
Richmond	39	13	48	150
El Cerrito del Norte	10	12	78	610
El Cerrito Plaza	26	18	56	440
North Berkeley	31	8	61	470
Berkeley	53	45	2	2,660
Ashby	36	12	52	330
Fremont	5	--	95	910
Union City	2	2	96	630
South Hayward	3	14	83	330
Hayward	13	29	58	840
Bay Fair	3	11	86	620
San Leandro	5	29	66	750
Coliseum	9	47	44	520
Fruitvale	9	47	44	870
Lake Merritt	59	3	38	730
MacArthur	10	28	62	920
19th Street Oakland	72	23	5	1,100
12th Street Oakland	47	41	12	1,390
Oakland West	52	7	41	370
Total All Stations	22%	16%	62%	26,100 (100%)

a. Automobile mode includes: Drove car alone, car pool (either driver or passenger), car drop-off or pick-up, taxi, motorcycle, and bicycle.

b. Midweek daily transbay person trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

Previous Mode of Travel for Transbay BART Journeys

Table V-11 shows the previous mode of transbay travel as reported by respondents to the BART transbay travel survey. The distribution of previous mode is shown both by trip destination (summarized by four groups of East Bay BART stations) and by trip purpose (summarized by trips between work and home, and trips for all other purposes).

For all transbay BART trips, Table V-11 shows that 54% were previously made by either AC Transit or Greyhound transbay buses, and 35% were previously made by automobile. Of these, 8% were trips made in car pools, either as a driver or passenger. The remaining 11% of trips were reported as not being made before the start of transbay BART service.*

Comparisons of Previous Transbay Travel Mode by Trip Purpose. Comparison of the previous mode for the two trip-purpose categories shown in Table V-11 indicates that the diversion of travel from bus was much higher for trips between work and home than for other purposes. Thus, 63% of all trips made on BART between work and home were previously made by bus. Only 34% of BART trips made for other purposes were previously made by bus. Correspondingly, the percentage of BART trips previously made by automobile was much lower for travel between work and home (29%) than for other purposes (49%).

Comparisons of Previous Transbay Travel Mode Among BART Lines. As has been discussed in previous sections, the majority of transbay BART ridership (11,400 trips) was to the Concord corridor. Of these trips, about 62% were previously made by bus, and of this percentage, most were made by Greyhound to Contra Costa County. The fact that the diversion from bus in the Concord corridor was proportionately greater than the other lines, in large part, reflects the way in which BART's Concord Line closely parallels the previous

*Caution should be exercised in interpreting the whole of this 11% as "induced" in the sense of being trips which would not have been made had BART not been running. The question included in the survey was: "How did you most often make the type of trip you are making on BART today before BART was running?" To this question, 11% responded "Did not make this trip before." As a result of the survey question wording, changes in the location of jobs and residences since the start of BART service accounted for some part of the "did not travel before" category. Trips which were made infrequently or were being made for the first time on the day of the survey (but which would have been made regardless of whether BART was available) are also included. Except insofar as some job or residence location changes have been caused by BART's opening, neither of these categories can properly be considered trips induced by BART. Trips reported as "did not make this trip before" in the survey, therefore, probably represent an upper estimate of the number of trips which were in fact induced.

Table V-11

PREVIOUS TRAVEL MODE OF TRANSBAY BART TRIPS[a]

Transbay Trips Made Before BART by	Destination of Travel[b]					Purpose of Travel	
	Concord Line BART Stations (6 stations)	Richmond Line BART Stations (6 stations)	Fremont Line BART Stations (8 stations)	Oakland BART Stations (5 stations)	Total	Trips Between Work and Home	Trips for All Other Purposes
Bus	7,100 62%	2,400 51%	2,500 47%	2,000 44%	14,000 54%	11,300 63%	2,700 34%
Drove car alone	2,200 19%	1,300 28%	1,900 34%	1,700 40%	7,100 27%	3,700 21%	3,400 42%
Traveled by car with others	1,000 9%	300 5%	600 10%	200 5%	2,100 8%	1,500 8%	600 7%
Did not make trip before	1,100 10%	700 16%	500 9%	600 11%	2,900 11%	1,500 8%	1,400 17%
Total	11,400 100%	4,700 100%	5,500 100%	4,500 100%	26,100 100%	17,900 100%	8,200 100%

a. Midweek daily transbay person-trips made eastbound between 6:00 a.m. and 8:00 p.m. (the hours of BART operation).
b. Stations are grouped as shown in Table V-10.

Source: BART Impact Program, October 1974 Survey of Transbay BART Travel.

Greyhound services. Like BART, Greyhound generally provided service only to and from central stations, necessitating the use of a separate access mode and a transfer for most travelers. However, because of the congestion encountered by buses in the Caldecott Tunnel and on the Bay Bridge, BART offered an appreciably faster line-haul journey. The generally higher income travelers residing in the Concord corridor were also probably more willing to pay the additional cost of the higher quality BART service.

It is interesting that the percentage of BART trips which were not previously made was noticeably higher for the Richmond Line than for the others. This reflects the influence of trips to the University of California at Berkeley. Of trips made to the Berkeley BART Station, 18% were reported as not having been made before, reflecting the high turnover of the student population.

Comparisons of Previous Mode for Transbay BART Journeys with Previous Mode for East Bay and San Francisco BART Journeys. The results of the May 1973 and May 1974 BART passenger profile surveys* allow comparison between the source of diversion of BART ridership for transbay and nontransbay travel. The distribution of prior mode for BART travel within the East Bay was, as shown by the 1973 survey, 56% automobile, 27% bus, 14% "did not make trip before," and 3% other. As shown by the 1974 survey, the prior mode for East Bay BART trips was 50% automobile, 24% bus, 24% "did not make trip before," and 2% other. Allowing for the fact that a year elapsed between the two surveys, thereby increasing the percentage of trips which were not made previously, the results of these two surveys are consistent. Comparing them with the transbay results (35% automobile, 54% bus, and 11% "did not make trip before"), shows that transbay BART ridership has been diverted from bus to a much greater extent than has been the case for East Bay BART trips. Among other reasons, this reflects (1) the higher proportion of total trips previously being made by transit in the transbay corridor than in the East Bay, (2) the longer trips being made across the congested Bay Bridge--which make the transfer to BART and the higher cost of BART more acceptable to travelers, and (3) the generally good bus service already provided by AC Transit in most of the central areas of the East Bay served by BART.

Comparison of the transbay BART previous modes of travel with the previous modes for BART travel within San Francisco, as indicated by the May 1974 passenger profile survey, shows the two distributions to be very close. The May 1974 survey showed for BART travel within San Francisco, the following distribution of prior mode: 30% automobile, 55% bus, 11% "did not make trip before," and 4% other modes. These results indicate the way in which both the transbay BART line and the BART line in San Francisco provided transit service in corridors where usage of the existing transit services was already high.

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*See notes following Table VI-3 on page 88 for descriptions of these surveys.

VI. PROFILES OF TRANSBAY TRAVELERS

Comparison of Transbay BART Traveler Profiles with Profiles of Bus and Automobile Travelers

Table VI-1 summarizes the distributions of age, sex, race, educational level, income, household size, and automobile ownership for travelers making transbay journeys by BART, bus, and automobile (both as drivers and passengers).

Travelers making transbay BART trips were, relative to bus riders, more likely to be male (69% compared to 54%), and white (89% compared to 80%). Family income and automobile ownership were also significantly higher for BART travelers than bus travelers: 25% of BART travelers reported incomes of $25,000 or over, compared to 20% for bus; household automobile ownership was 1.72 for BART travelers and 1.50 for bus travelers. To some extent, these comparisons reflect the ability and willingness of higher income travelers to pay the higher cost of traveling by BART. However, they reflect more the types of trips served most effectively by BART. These are largely the long-distance commute trip from the high- and middle-income (and mainly white) suburbs of the East Bay to the employment centers of downtown San Francisco.

The distributions of traveler characteristics for BART and automobile travelers were remarkably similar in almost all respects. The only significant difference between the two is for household automobile ownership, which was higher for automobile trip-makers (1.93) than for BART trip-makers (1.72). This is a reflection of the "transit captive" component of BART ridership.

Comparison of Transbay BART Traveler Profiles by Previous Mode of Travel

Table VI-2 shows the socioeconomic characteristics of transbay BART travelers according to their previous mode of transbay travel, including those who did not make the trip before.

Comparing Tables VI-1 and VI-2, it can be seen that the distributions of characteristics were similar in all respects for those transbay BART travelers who previously used automobile and for those who continued to use automobile. However, there were significant differences between the distributions for previous bus travelers and current bus travelers, particularly for sex, race, and income level. This reflects the extent of the diversion to transbay BART of predominantly male, white, upper income travelers who previously rode Greyhound Bus from Contra Costa County. For this reason, comparison of the distributions shown in Table VI-2 for those who previously used automobile and those who previously used bus, reveals few noteworthy differences.

Comparison of the socioeconomic profile of transbay travelers who previously did not make the trip with those who did shows a number of significant differences. The new trips on BART are shown as having been made by travelers

Table VI-1

TRANSBAY TRAVELER PROFILES
(Comparisons Among Transbay Modes)
October 1974

	Current Transbay Trips			
	BART Trips	Bus Trips	Automobile Trips	Total Transbay Trips
Age				
Under 18	1%	1%	1%	1%
18-24	17	14	9	11
25-34	35	35	37	36
35-44	19	19	22	21
45-54	17	18	18	18
55-64	8	11	10	10
65 or over	3	2	3	3
Sex				
Male	69%	54%	72%	69%
Female	31	46	28	31
Race[a]				
White	89%	80%	87%	87%
Spanish-American	3	2	2	3
Black	3	7	5	5
Oriental	4	10	4	5
Other	1	1	1	1
Education				
Less than high school graduate	2%	2%	2%	2%
Graduated from high school	11	13	10	11
Some college or junior college	29	27	30	29
Four year college graduate	23	24	21	22
More than four years of college	35	34	37	36
Annual Family Income[b]				
Less than $5,000	7%	4%	5%	5%
$5,000-$9,999	13	21	12	14
$10,000-$14,999	18	21	22	21
$15,000-$19,999	19	17	18	18
$20,000-$24,999	18	17	17	17
$25,000 or over	25	20	26	25
Category of Income and Race				
White				
Under $10,000	16%	18%	13%	14%
$10,000-$19,999	33	29	34	33
$20,000 or over	40	34	39	39
Nonwhite[c]				
Under $10,000	4	6	3	4
$10,000-$19,999	4	9	5	6
$20,000 or over	3	4	6	4
Household Size[d]	2.32	2.23	2.28	2.28
Household Automobile Ownership[e]	1.72	1.50	1.93	1.84
TOTAL TRANSBAY TRIPS[f]	26,100 (100%)	17,100 (100%)	92,400 (100%)	135,600 (100%)

a. Racial/ethnic categories as included in the survey questionnaires.
b. Total annual family income before taxes.
c. Spanish-American, Black, Oriental, and Other races.
d. Mean number of people aged 16 or over living in the household.
e. Mean number of automobiles and pick-up trucks in the household.
f. Daily trips in one (eastbound) direction, October 1974.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Table VI-2

TRANSBAY TRAVELER PROFILES
(Comparisons by Previous Mode of Travel)
October 1974

	Previous Mode of Travel for BART Trips			
	Previously Used Bus	Previously Used Automobile	Did Not Make Trip Previously	Total BART Trips
Age				
Under 18	1%	1%	2%	1%
18-24	14	15	30	17
25-34	32	39	40	35
35-44	21	18	11	19
45-54	19	16	11	17
55-64	10	7	3	8
65 or over	3	4	3	3
Sex				
Male	68%	73%	63%	69%
Female	32	27	37	31
Race[a]				
White	88%	91%	84%	89%
Spanish-American	4	2	9	3
Black	3	3	3	3
Oriental	4	4	4	4
Other	1	--	--	1
Education				
Less than high school graduate	1%	2%	3%	2%
Graduated from high school	11	11	15	11
Some college or junior college	31	26	30	29
Four year college graduate	23	24	21	23
More than four years of college	34	37	31	35
Annual Family Income[b]				
Less than $5,000	6%	5%	16%	7%
$5,000-$9,999	12	13	19	13
$10,000-$14,999	18	18	17	18
$15,000-$19,999	19	19	21	19
$20,000-$24,999	20	17	12	18
$25,000 or over	25	28	15	25
Category of Income and Race				
White				
Under $10,000	14%	15%	29%	16%
$10,000-$19,999	32	35	34	33
$20,000 or over	43	42	20	40
Nonwhite[c]				
Under $10,000	4	2	6	4
$10,000-$19,999	5	3	4	4
$20,000 or over	2	3	7	3
Household Size[d]	2.32	2.31	2.37	2.32
Household Automobile Ownership[e]	1.66	1.87	1.57	1.72
TOTAL TRANSBAY TRIPS[f]	14,000 (100%)	9,200 (100%)	2,900 (100%)	26,100 (100%)

a. Racial/ethnic categories as included in the survey questionnaires.
b. Total annual family income before taxes.
c. Spanish-American, Black, Oriental, and Other Races.
d. Mean number of people aged 16 or over living in the household.
e. Mean number of automobiles and pick-up trucks in the household.
f. Daily trips in one (eastbound) direction, October 1974.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

who were more predominantly young, female, and nonwhite; who had completed less advanced education; and who had significantly lower incomes than the typical transbay BART trip-maker. Before conclusions regarding BART's impacts on the mobility of disadvantaged groups are drawn from this evidence, it should be pointed out that the findings are not inconsistent with the fact that the new school year at the University of California began between the start of transbay BART service on September 16 and the October 30 survey date. This explanation is supported by the survey results which show that for the Berkeley BART Station (where 45% of trips were to or from school or college), 18% of trips had not been made previously, compared to 11% for all transbay trips.

Comparison of Transbay BART Traveler Profiles with East Bay and San Francisco BART Traveler Profiles

Table VI-3 summarizes the BART traveler characteristics revealed by the May 1973 Passenger Profile Survey of travelers on the Richmond-Fremont Line; the May 1974 Passenger Profile Survey of all BART lines except the transbay link;* and the October 1974 survey of BART travel.

Comparisons of BART Passenger Profiles for East Bay and San Francisco Journeys. Comparisons of the May 1973 and May 1974 data for the East Bay show similar distributions for all characteristics except family income, which appears to be appreciably higher in 1974 than 1973 (44% having incomes over $15,000 for 1974 compared to 31% for 1973).

The 1974 distributions for BART travel on the East Bay and in San Francisco are also generally similar, with trips made within San Francisco tending, if anything, to be made by slightly more nonwhite and lower income persons.

Comparison of 1974 BART Traveler Profiles for Transbay and Nontransbay Journeys. Comparisons between the results of the October 1974 transbay surveys and either the East Bay or San Francisco May 1974 BART traveler profiles reveal a number of significant differences. A significantly higher proportion of transbay BART travelers were white, male, well-educated, and upper income than nontransbay BART riders. For example, 35% of transbay BART travelers had more than four years of college compared to 12% for East Bay travelers and 16% for San Francisco travelers. Transbay BART travelers also had significantly higher income levels; 25% having annual family incomes of over $25,000 compared to 13% for East Bay BART travelers and 10% for San Francisco travelers.

*Some 1,200 transbay travelers were included in the passenger profile surveys; these were travelers who transferred from BART to AC Transit buses at the MacArthur BART Station.

Table VI-3

BART TRAVELER PROFILES
(Comparison of East Bay, San Francisco, and Transbay Trips)

	East Bay BART Trips		San Francisco BART Trips	Transbay BART Trips
	1973[a]	1974[b]	1974[b]	1974[c]
Age				
Under 18	3%	3%	3%	1%
18-24	30	28	25	17
25-34	32	30	36	35
35-44	14	16	16	19
45-54	12	13	12	17
55-64	6	7	6	8
65 or over	3	3	2	3
Sex				
Male	49%	52%	47%	69%
Female	51	48	53	31
Race[d]				
White	76%	81%	69%	89%
Spanish-American	5	4	8	3
Black	12	8	8	3
Oriental	4	4	11	4
Other	3	3	4	1
Education				
Less than high school graduate	5%	7%	5%	2%
Graduated from high school	25	25	21	11
Some college or junior college	39	40	39	29
Four year college graduate	18	16	19	23
More than four years of college	13	12	16	35
Annual Family Income[e]				
Less than $5,000	14%	11%	8%	7%
$5,000-$9,999	26	20	26	13
$10,000-$14,999	29	25	27	18
$15,000-$25,000	25	31	29	37
$25,000 or over	6	13	10	25
TOTAL TRIPS	24,900[f] (100%)	40,700[g] (100%)	25,400[g] (100%)	51,500[h] (100%)

See footnotes on following page.

Table VI-3 (Cont.)

BART TRAVELER PROFILES
(Comparison of East Bay, San Francisco, and Transbay Trips)

Footnotes to Table VI-3

a. Source: BARTD, May 1973 Passenger Profile Survey. At the time of this survey (conducted by BARTD on Tuesday, May 8, 1975), only the Richmond to Fremont line was in operation. The survey sampling design was a 100% questionnaire handout at all 18 stations on the system between 6:00 a.m. and 2:00 p.m. (half the BART operating day). About 7,300 questionnaires were returned, a 50% response rate overall. However, the response rate for questionnaires handed out over the morning peak period was much higher than for those handed out later in the day (74% before 9:00 a.m. compared to 35% after 9:00 a.m.). The survey results summarized here have not been weighted to reflect differential response rates either by time of day or by location. The results are consequently biased toward the characteristics of early morning riders, and may be biased in other (unknown) ways.
b. Source: BARTD, May 1974 Passenger Profile Survey. This survey was conducted by BARTD on Wednesday, May 22, 1974, when all lines of the BART System were in operation with the exception of the transbay link. A sampling design similar to that employed in the May 1973 Passenger Profile Survey was used, with about 17,200 questionnaires being returned. The survey results presented are not weighted to account for differential response rates and are, therefore, subject to bias in the same way as the 1973 results.
c. Source: BART Impact Program, October 1974 Survey of Transbay BART Travelers (Sample: 2,000). Results are weighted to reflect different response rates by time of day and location of questionnaire handout.
d. Racial/ethnic categories are as included in the questionnaires of all three passenger profile and transbay BART surveys.
e. Total annual family income before taxes.
f. Average daily BART patronage for May 1973.
g. Average daily BART patronage for May 1974.
h. Control total for October 30, 1974, survey of transbay travel (sum of eastbound and westbound trips).

Comparison of Transbay BART Traveler Profiles with Nontransbay Traveler Profiles for Selected BART Stations. The differences between BART passenger profiles by station of entry or exit, as well as differences between profiles for transbay travel and nontransbay travel are illustrated in Table VI-4. BART passenger profiles are shown for Walnut Creek and Fruitvale stations on the East Bay, and 24th Street-Mission and Daly City on the West Bay.*

The variations among stations were predictably large, reflecting the demographics of the areas surrounding the stations. Thus, the percentage of nonwhite travelers varied from 3% for Walnut Creek to 35% for Fruitvale; the proportion of travelers with a family income of less than $5,000 per year varied from zero for Walnut Creek to 27% for the 24th Street-Mission Station.

It is also evident that, for the stations shown, transbay BART journeys were generally made by a higher proportion of male, white, well-educated, and high-income travelers than were the shorter BART journeys made to destinations on the same side of the Bay. This reflects the concentration of male-dominated professional jobs in San Francisco.

Use of Transbay BART by Minorities for "Reverse Commute" Journeys

In Chapter V, the numbers of transbay journeys being made by residents of San Francisco to work places in the East Bay ("reverse commute" journeys) were discussed. One of the hypothesized influences of BART has been the way in which it has increased job accessibility for disadvantaged groups in the population, particularly low-income and racial minorities. To the extent that many of these people live in the City of San Francisco and have job opportunities in the industrial areas of the East Bay, it is interesting to compare the socioeconomic characteristics of transbay BART travelers making the reverse commute journey with those traveling by automobile.**

Of the journeys made from East Bay residences to work in San Francisco by automobile (36,900 daily trips), 13% were made by nonwhites.*** Correspondingly, 13% were made by people with family incomes of less than $10,000. Of the reverse commute journeys made from San Francisco residences to East Bay work places by automobile (15,300 daily trips), 17% were made by nonwhites, and 18% by people with family incomes under $10,000.

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*In conjunction with the questionnaire handout survey of BART travelers conducted on October 30, 1974, an observational census of BART travelers entering 24th Street-Mission and Daly City BART Stations was conducted. As part of this census, the sex and race of travelers were observed. Comparisons of the census results with the May 1974 and October 1974 on-route survey results (given in Appendix A) show close correspondence.

**The sample of people making the reverse commute journey by bus was so small as to preclude meaningful comparisons with BART.

***The term "nonwhite" is used here to describe all those persons who reported their ethnic category as "Spanish-American," "Black," "Oriental," or "Other."

Table VI-4

BART TRAVELER PROFILES FOR TRANSBAY AND NONTRANSBAY TRAVEL
(Comparisons Among Selected BART Stations)

	Walnut Creek		Fruitvale		24th Street - Mission		Daly City	
	East Bay[a]	Transbay[b]	East Bay[a]	Transbay[b]	San Francisco[a]	Transbay[b]	San Francisco[a]	Transbay[b]
Age								
Under 18	3%	--%	3%	7%	2%	2%	1%	5%
18-24	21	9	38	20	26	21	22	24
25-34	27	33	31	35	45	52	38	36
35-44	19	23	8	7	14	9	17	8
45-54	16	26	9	9	7	10	14	14
55-64	10	7	6	15	4	5	6	11
65 or over	4	2	5	7	2	1	2	2
Sex								
Male	64%	73%	45%	59%	47%	64%	44%	78%
Female	36	27	55	41	53	36	56	22
Race[c]								
White	97%	95%	65%	84%	70%	71%	71%	80%
Spanish-American	1	2	11	10	16	14	8	6
Black	--	--	14	3	3	5	7	7
Oriental	1	3	5	3	7	7	10	6
Other	1	--	5	--	4	3	4	1
Education								
Less than high school graduate	3%	1%	7%	7%	6%	4%	3%	4%
Graduated from high school	12	5	28	23	23	12	28	11
Some college or junior college	31	27	40	40	40	34	38	33
Four year college graduate	31	28	14	13	17	13	18	16
More than four years of college	23	39	11	17	14	37	13	36
Annual Family Income[d]								
Less than $5,000	4%	--%	19%	6%	14%	27%	4%	6%
$5,000-$9,999	13	4	30	30	36	12	23	20
$10,000-$14,999	18	20	26	24	25	22	28	22
$15,000-$25,000	43	38	20	29	21	30	37	43
$25,000 or over	22	38	5	11	4	9	8	9
TOTAL TRIPS PER DAY[e]	1,740 (100%)	2,080 (100%)	1,470 (100%)	870 (100%)	1,590 (100%)	780 (100%)	5,930 (100%)	1,140 (100%)

a. Source: BARTD, May 1974 Passenger Profile Survey. This survey was conducted by BARTD on Wednesday, May 22, 1974, when all lines of the BART System were in operation with the exception of the transbay link. A sampling design similar to that employed in the May 1973 passenger survey was used, with about 17,200 questionnaires being returned. The survey results presented are not weighted to account for differential response rates and are, therefore, subject to bias in the same way as the 1973 results (see footnote a. to Table IV-3). All figures are for travelers entering the stations between 6:00 a.m. and 2:00 p.m.

b. Source: BART Impact Program, October 1974 Survey of Transbay BART Travelers (Sample: 2,000). Results are weighted to reflect different response rates by time of day and location of questionnaire handout. Figures for Walnut Creek and Fruitvale Stations are for travelers exiting the stations (all day), and figures for 24th Street-Mission and Daly City are for travelers entering.

c. Racial/ethnic categories are as included in the questionnaires of all three passenger profile and transbay BART surveys.

d. Total annual family income before taxes.

e. East Bay and San Francisco totals are BART faregate entry patron counts for May 22, 1974. Transbay totals are derived from the BART Impact Program, October 1974 Transbay BART Survey.

On BART, 15,600 trips a day were made from San Francisco work places to residences in the East Bay. Of these trips, 8% were made by nonwhites and 12% by people with an annual family income of less than $10,000. In the reverse direction, 2,300 BART trips to work were made, of which 21% were by nonwhites and 25% by people with family incomes of under $10,000.

These figures suggest that, for the predominant direction of travel, BART serves a slightly higher proportion of white and high-income travelers than the average for all transbay travel. However, in the reverse commute direction, BART's ridership is made up of appreciably more low-income and minority travelers than is the case for transbay travel as a whole.

The present analysis does not permit a meaningful conclusion about the way in which BART has changed patterns of reverse commuting by low-income and minority persons since, among other things, the previous mode of travel for these traveler groups has not been investigated. However, the limited evidence presented here suggests that BART is being used by people from racial minority and low-income groups to travel to work in the East Bay from San Francisco to a proportionately greater extent than other modes.

VII. TRANSBAY TRAVEL IMPEDANCES AND TRAVELER ATTITUDES

Travel Times and Costs of Transbay Trips

Tables VII-1, VII-2, and VII-3 summarize the travel times and costs of, respectively, (1) trips currently being made transbay by BART, bus, and automobile; (2) the previous bus or automobile trips of BART travelers; and (3) hypothetical BART trips for bus and automobile travelers. The latter are the times and costs that bus and automobile travelers estimated would be the case if they were to use BART for their transbay trip. In some cases, respondents had tried BART for the trip, and in other cases, they had not.*

Comparisons among BART, Bus, and Automobile Trips. As shown by Table VII-1, transbay trips being made on BART have significantly longer travel times on the average (58 minutes) than either bus trips (48 minutes) or automobile trips (35 minutes). With an average one-way trip cost of $1.35,** BART trips are significantly more expensive than bus trips ($0.90) but much cheaper than travelers' perceptions of automobile trip costs ($3.05).

Comparisons between BART Trips and Trips Previously Made by Bus or Automobile. Table VII-2 shows that, for those transbay BART travelers who previously rode the bus, the average trip by BART took slightly less time (58 minutes compared to 62 minutes) but cost slightly more ($1.30 compared to $1.25). Thus, a small time-for-money trade-off was being made.

For those transbay BART travelers who switched from automobile, BART took substantially more time for the door-to-door journey (57 minutes compared to 44 minutes previously) but was perceived by those travelers as being very much less costly ($1.50 compared to $3.00). Thus, in contrast to those travelers diverted from bus, previous automobile travelers made a money-for-time trade-off in taking BART.

Comparisons of Current Trips on Bus and Automobile with Hypothetical BART Trips. The times and costs shown in Table VII-3 provide some limited clues to the reasons BART was not being used for many transbay trips. For trips then being made by bus, travelers perceived BART as both taking

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*58% of transbay bus travelers had tried BART for the trip; 27% of transbay automobile travelers had tried BART.

**The transit fare component of this cost, $1.00, reflects an average transbay BART trip length of 21.5 miles. Starting from Powell Street Station in San Francisco, this average trip length would take the transbay BART traveler to approximately the Richmond (20.4 miles), Walnut Creek (23.4 miles), or Hayward (21.7 miles) Stations on the three East Bay lines.

Table VII-1

TRAVEL TIMES AND COSTS OF TRANSBAY BART, BUS, AND AUTOMOBILE TRIPS[a]
October 1974

	Current Transbay BART Trips	Current Transbay Bus Trips	Current Transbay Automobile Trips
Door-to-Door Travel Time	58 minutes	48 minutes	35 minutes
Access Time[b]	14 minutes	12 minutes	--
Transit Cost	$1.00	$0.80	$ --
Automobile Cost[c]	0.35	0.10	3.05
Total Trip Cost	$1.35	$0.90	$3.05

a. Average times and costs (to nearest $0.05) for one-way trips as reported by survey respondents.
b. Access times to bus or BART (San Francisco) plus access time from bus or BART (East Bay).
c. Toll, parking, and other automobile operating costs as perceived by survey respondents.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Table VII-2

TRAVEL TIMES AND COSTS OF TRANSBAY BART TRIPS AND PREVIOUS MODE TRIPS[a]
October 1974

	For Transbay Trips Previously Made by Bus	
	Previous Bus Trip	Current BART Trip
Door-to-Door Travel Time	62 minutes	58 minutes
Access Time[b]	n.a.	14 minutes
Transit Cost	$0.95	$1.00
Automobile Cost[c]	0.30	0.30
Total Trip Cost	$1.25	$1.30

	For Transbay Trips Previously Made by Automobile	
	Previous Automobile Trip	Current BART Trip
Door-to-Door Travel Time	44 minutes	57 minutes
Access Time[b]	n.a.	14 minutes
Transit Cost	$ --	$1.00
Automobile Cost[c]	3.00	0.50
Total Trip Cost	$3.00	$1.50

a. Average times and costs (to nearest $0.05) for one-way trips as reported by survey respondents.
b. Access time to bus or BART (San Francisco) plus access time from bus or BART (East Bay).
c. Toll, parking, and other automobile operating costs as perceived by survey respondents.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Table VII-3

TRAVEL TIMES AND COSTS OF ACTUAL TRANSBAY BUS AND AUTOMOBILE TRIPS AND HYPOTHETICAL BART TRIPS[a]
October 1974

	For Transbay Trips Currently Made by Bus	
	Actual Bus Trip	Hypothetical BART Trip
Door-to-Door Travel Time	48 minutes	59 minutes
Access Time[b]	12 minutes	19 minutes
Total Trip Cost	$0.90	$1.10

	For Transbay Trips Currently Made by Automobile	
	Actual Automobile Trip	Hypothetical BART Trip
Door-to-Door Travel Time	35 minutes	61 minutes
Access Time[b]	--	20 minutes
Total Trip Cost	$3.05	$1.95

a. Average times and costs (to nearest $0.05) for one-way trips as reported by survey respondents.
b. Access time to bus or BART (San Francisco) plus access time from bus or BART (East Bay).

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

significantly more time (59 minutes compared to 48 minutes) and costing more ($1.10 compared to $0.90). Most of the difference between the travel times is accounted for by the access component.

Automobile travelers perceived their trip cost would be significantly lower ($1.95 compared to $3.05), but this cost savings was not sufficient to offset the greatly increased travel time (61 minutes compared to 35 minutes) involved in the BART journey. About 20 minutes of the BART journey time would be spent in getting to or from BART itself.

Traveler Attitudes Toward Transbay BART and Alternative Modes

The travel times and costs summarized in the previous section suggest some reasons why BART was or was not being used for transbay trips. However, times and costs averaged over all travelers conceal the possibly large variations among individuals. Also, although travel times and costs are among the most important reasons for travel choice, there are many other travel "impedances" or factors which influence choice. The list of factors given in Table VII-4 are the 14 included in the transbay travel survey questionnaires.

Transbay travelers can be considered to choose between BART and the bus or automobile on the basis of two kinds of "attitudes" toward the characteristics of the travel alternatives. These are the importance they attach to difference factors and their relative satisfaction with the levels of the factors for the alternative modes. Thus, a traveler chooses BART over bus as a function of (among other things) how much more satisfied he is with the comfort of BART relative to bus and how important comfort is to him relative to cost, time, and other factors. Summaries of traveler attitudes regarding factor importance and satisfaction are given in Tables VII-5, VII-6, and VII-7.*

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*It should be emphasized that the rankings shown in these tables are derived from mean scale ratings for groups of travelers. Accordingly, there are fairly large variances about the mean estimates for some factors, reflecting differences in the attitudes of individuals in the groups. Moreover, the differences between means is in many cases small. In combination, these influences mean the relative position of factors within a given ranking is not an exact indicator of the relative strengths of attitudes; nor are differences between rankings of less than about three positions in the scale likely to be significant.

It should also be acknowledged that the rankings given in Tables VII-5, VII-6, and VII-7 represent an initial approach to analysis of the attitudinal data collected in the surveys. It is anticipated that additional, more sophisticated analysis of these data will be undertaken in later phases of the Transportation System and Travel Behavior Project.

Table VII-4

CORRESPONDENCE BETWEEN FACTOR DESCRIPTIONS
INCLUDED IN QUESTIONNAIRE AND ABBREVIATIONS
USED IN TABULATIONS

Factor Description Used in Questionnaire	Abbreviation
Your total door-to-door travel time	Total time
Your walking time during the trip	Walking time
The time you spend waiting	Waiting time
Dependability of arriving on time	Dependability
Your chances of getting a seat	Seat availability
Comfort and smoothness of ride	Comfort
Safety from accident or injury	Safety
Security from crime and unpleasant behavior of other people	Security
Feeling of privacy	Privacy
Ability to do what you want while traveling	Activity en route
Flexibility to travel when you want to	Flexibility
Ability to combine different purposes in a single trip	Multipurpose
Total cost of your door-to-door trip	Cost
Ability to find a place to park	Parking space

Table VII-5

IMPORTANCE OF TRAVEL FACTORS (IMPEDANCES) IN TRANSBAY TRAVEL CHOICE
(Factors Ranked in Order of Importance)
October 1974

	Current Transbay BART Travelers		Current Transbay Bus Travelers		Current Transbay Automobile Travelers			
	Previously Drove Automobile	Previously Rode Bus	Have Tried BART	Have Not Tried BART	Automobile Drivers	Automobile Passengers	Have Tried BART	Have Not Tried BART
Most Important:	Cost	Total time	Total time	Total time	Flexibility	Total time	Total time	Flexibility
	Comfort	Comfort	Dependability	Dependability	Total time	Flexibility	Flexibility	Travel time
	Total time	Dependability	Seat availability	Seat availability	Multipurpose	Dependability	Dependability	Multipurpose
	Safety	Cost	Waiting time	Cost	Dependability	Waiting time	Multipurpose	Dependability
	Activity en route	Flexibility	Cost	Waiting time	Waiting time	Cost	Waiting time	Waiting time
	Parking space	Waiting time	Walking time	Walking time	Cost	Multipurpose	Cost	Cost
	Dependability	Seat availability	Flexibility	Safety	Activity en route	Security	Activity en route	Activity en route
	Flexibility	Walking time	Comfort	Flexibility	Security	Activity en route	Seat availability	Security
	Walking time	Security	Activity en route	Comfort	Privacy	Waling tine	Privacy	Privacy
	Waiting time	Safety	Safety	Security	Walking time	Seat availability	Security	Walking time
	Security	Privacy	Security	Activity en route	Parking space	Parking space	Walking time	Parking space
	Seat availability	Parking space	Parking space	Parking space	Safety	Comfort	Comfort	Safety
	Multipurpose	Multipurpose	Multipurpose	Multipurpose	Seat availability	Privacy	Parking space	Seat availability
Least Important:	Privacy	Activity en route	Privacy	Privacy	Comfort	Safety	Safety	Comfort

Note: The rankings of factor importance are based on the aggregate of the times each factor was mentioned by survey respondents as being either the first, second, third, or fourth most important reason in their choice of mode.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Table VII-6

SATISFACTION OF TRANSBAY TRAVELERS WITH BART
(Factors Ranked in Order of Satisfaction with BART)
October 1974

	Current Transbay BART Travelers			Current Transbay Automobile Travelers	
	Previously Drove Automobile	Previously Rode Bus	Current Transbay Bus Travelers	Automobile Drivers	Automobile Passengers
Most Satisfied:	Comfort	Comfort	Comfort	Comfort	Comfort
	Safety	Security	Security	Safety	Safety
	Security	Safety	Safety	Parking space	Parking space
	Walking time	Walking time	Walking time	Seat availability	Security
	Cost	Activity en route	Activity en route	Activity en route	Seat availability
	Activity en route	Flexibility	Parking space	Security	Activity en route
	Seat availability	Parking space	Privacy	Cost	Walking time
	Parking space	Cost	Flexibility	Walking time	Cost
	Total time	Total time	Multipurpose	Privacy	Dependability
	Dependability	Multipurpose	Cost	Dependability	Privacy
	Privacy	Privacy	Seat availability	Total time	Flexibility
	Flexibility	Dependability	Dependability	Flexibility	Total time
	Multipurpose	Waiting time	Total time	Waiting time	Waiting time
Least Satisfied:	Waiting time	Seat availability	Waiting time	Multipurpose	Multipurpose

Note: The rankings of satisfaction with BART's factors are based on the mean of satisfaction ratings given by respondents for each factor. (Ratings were recorded on a 7-point linear semantic scale from "very satisfied" to "very dissatisfied".) Thus, for example, BART travelers who previously rode the bus gave on average the lowest (least satisfied) rating to the seat availability factor in their BART trip.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Table VII-7

SATISFACTION OF TRANSBAY TRAVELERS WITH BART RELATIVE TO ALTERNATIVE MODES
(Factors Ranked in Order of Relative Satisfaction with BART)
October 1974

	Current Transbay BART Travelers			Current Transbay Automobile Travelers	
	Previously Drove Automobile	Previously Rode Bus	Current Transbay Bus Travelers	Automobile Drivers	Automobile Passengers
Most Satisfied:	Cost	Comfort	Comfort	Safety	Safety
	Safety	Flexibility	Security	Cost	Parking space
	Activity en route	Multipurpose	Safety	Comfort	Comfort
	Parking space	Walking time	Multipurpose	Parking space	Cost
	Comfort	Total time	Flexibility	Security	Activity en route
	Total time	Security	Privacy	Activity en route	Security
	Walking time	Safety	Parking space	Walking time	Total time
	Security	Cost	Activity en route	Total time	Dependability
	Dependability	Activity en route	Cost	Seat availability	Walking time
	Waiting time	Parking space	Walking time	Dependability	Seat availability
	Seat availability	Waiting time	Waiting time	Privacy	Flexibility
	Privacy	Privacy	Total time	Waiting time	Waiting time
	Multipurpose	Dependability	Dependability	Flexibility	Privacy
Least Satisfied:	Flexibility	Seat availability	Seat availability	Multipurpose	Multipurpose

Note: The rankings are based on relative factor satisfaction ratings obtained by subtracting the mean of the satisfaction ratings for the bus or automobile mode (either current or previous) from the mean ratings used in Table VII-6. Thus, for example, for those BART travelers who previously drove, the difference of the average rating for the cost of travel on BART minus the average rating for the cost of travel for automobile was the largest (most favorable to BART) of 14 factors.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

Relative Importance of Factors in Transbay Travel Choice. First, in comparing the several rankings shown in Table VII-5, it is interesting to note that attitudes regarding factor importance were not noticeably different between those who had tried BART and those who had not tried BART. This was true for both bus and automobile travelers, with the one exception that those who had tried BART and returned to using their automobiles considered seat availability rather more important than either those who had not tried BART or those who had previously driven and changed to BART. This is also true regarding the satisfaction of non-BART travelers with BART's characteristics: those who had tried BART had very similar attitudes to those who had not. This suggests that people who do not ride BART are reasonably aware and well-informed about BART as an alternative mode.

A second conclusion which can be drawn from Table VII-5 is that the basic factors which are considered important by travelers do not vary radically as a function of the mode used. Thus, although there are some significant and interesting differences, travel time, cost, and dependability appear at or near the top of the importance ranking for all groups. This lends credibility to the data set as a whole.

Third, it is noticeable that BART travelers who previously rode bus were generally very similar in attitude to those who continued to use bus. The two noticeable exceptions were the rankings for comfort, which was considered more important by those who had switched to BART, and seat availability which was considered more important by those who had not switched. This suggests that the decision of bus travelers to switch to BART is largely dependent on whether or not they get a seat on BART.

The differences between the importance ratings for BART travelers who previously drove across the Bay Bridge and those who continued to drive were much more pronounced. Those who had switched to BART considered cost, comfort, safety, and ease of parking relatively important; those who continued to drive emphasized the obvious advantages of the automobile as being important: the flexibility of being able to travel when they want, the ability to combine trip purposes, and not having to spend time waiting.

Comparing the importance rankings of BART travelers according to their previous mode shows the following differences between those who rode the bus and those who drove: Previous automobile travelers considered safety from accidents, the ability to do what they want while traveling, and ease of parking more important. Previous bus riders, who had become accustomed to these advantages of transit, considered dependability, the time they have to spend waiting, and the chances of getting a seat significantly more important than those who previously drove. This is an interesting reflection of the way in which travelers' attitudes are modified by their travel experience.

Finally, it is noteworthy that "security from crime and unpleasant behavior of other people" was listed as relatively unimportant by all transbay traveler groups, along with "feeling of privacy" (even among automobile drivers).

Satisfaction with Transbay BART Trips. Table VII-6 shows that satisfaction with BART's comfort, safety, and security was high for all traveler groups, both those who use BART and those who do not. Attitudes among automobile drivers and passengers were also very similar. Apart from these commonalities, a number of differences are noteworthy.

BART travelers who previously rode the bus and current bus travelers had basically similar attitudes toward BART's characteristics. The only significant difference is that current bus travelers were less satisfied with BART's travel time than those who changed to BART; but this should come as no surprise given that their trips would, on the average, take 11 minutes (23%) longer by BART. Among the characteristics of BART with which both these groups were least satisfied are the chances of getting a seat on BART, its dependability, and, associated with this, the time spent waiting.

Automobile travelers and those who diverted from automobile to BART also had very similar attitudes about BART; the one noticeable difference being that those who rode BART (and used their automobile to get to the BART station) were much less satisfied with the ease of finding a place to park than were those who did not use BART.

As might be expected, both previous and current automobile travelers rated the "travel time flexibility" and the "ability to combine trip purposes" poorly for BART. They were also dissatisfied with the dependability of BART and the associated waiting time involved.

Relative Satisfaction of Transbay BART and Alternative Mode Trips

The satisfaction ratings given in Table VII-7 show the attitudes of travelers toward BART relative to their alternative mode--either used now or previously. These rankings show some significantly different patterns from the corresponding rankings shown in Table VII-6.

For those who either previously rode or currently ride the bus, BART was perceived as being significantly more comfortable. Safety, security, flexibility to travel when you want, and the ability to combine different trip purposes also came high on the list (although it is interesting that BART's security and safety were rated rather higher by bus travelers than by those who actually ride BART). BART was perceived as being considerably less attractive than bus with regard to seat availability, dependability, and the waiting time required. Significantly, those who rode the bus were much less satisfied with their trip travel time on BART relative to bus than were those who rode BART. On the other hand, the cost of the BART trip relative to bus was not perceived as being significantly different by either group.

For those travelers who either drive, or use BART and drove previously, BART was perceived as being more attractive than automobile primarily with regard to cost, safety from accidents, comfort, the ability to find a place to park, and the opportunity to do what you want while traveling. BART was viewed in relative terms as being least attractive with regard to the freedom it allows for travel when one wants to combine trips, privacy, waiting time, and dependability. Satisfaction with total travel time, the time spent walking, and security were not perceived very differently.

VIII. CONCLUSIONS

Sources of BART's Transbay Ridership

From the start of service in September 1974 to the end of the year, BART's daily transbay ridership averaged about 26,000 passengers in each direction. Over half of this ridership was diverted from the preexisting bus services of AC Transit and Greyhound Lines. A further 10,000 trips would otherwise probably have been made by automobile (as drivers or passengers), and about 2,000 were trips that would probably not have been made at all if BART had not been available.

BART's transbay ridership was composed mainly of trips made between residences in the East Bay and work places in San Francisco (about 60% of all trips). Correspondingly, travel was concentrated in the peak periods. For example, about 53% of eastbound ridership occurs during the three hours from 3:00 p.m. to 6:00 p.m.

Reduction of San Francisco-Oakland Bay Bridge Traffic. All other factors remaining equal, those findings might have led one to expect that the diversion of automobile trips to transbay BART would reduce weekday automobile traffic on the San Francisco-Oakland Bay Bridge by something like 7,000 vehicles in each direction, with the majority of these being removed during the congested peak periods. However, no such marked reduction in Bay Bridge traffic was observed. Relative to average weekday traffic in October 1973, average traffic levels for October 1974 showed a reduction of about 2,000 vehicles over the day, and in the morning peak period (6:00 a.m. to 9:00 a.m.), there was no significant reduction in traffic.

These comparisons do not take into account any secular growth in the Bay Bridge traffic which may have occurred over the period. (From 1971 to 1973, the increase was at an annual rate of about 2,000 daily vehicles.) However, traffic levels on the Bay Bridge in 1974 before the start of transbay BART, as well as traffic levels on the San Mateo-Hayward and Richmond-San Rafael Bridges, suggest that the effects of the gasoline shortage and associated price increases in the winter of 1973-1974 served to halt the steady upward trend of the previous three years. This leaves the conclusion that the net decrease in Bay Bridge traffic attributable to BART was probably not much more than 2,000 vehicles per day. This reduction is about 2% of average daily traffic, or about the equivalent of the average annual growth in traffic in each of the previous three years. Viewed in this way, BART's apparent effect on Bay Bridge traffic was to displace the recent traffic growth trend by about one year, although it remains to be seen whether Bay Bridge traffic will continue to grow at a similar rate in the future.

Over the peak period, BART's apparent effect was to reduce the length of time over which high Bay Bridge traffic levels occur, rather than to reduce significantly the traffic volumes occurring at the busiest times. In other words, automobile travelers may have been traveling at a more preferred time (closer to the height of the peak), but the were still encountering traffic congestion.

Generation of Transbay Travel. Over the year from October 1973 to October 1974, the relatively small decrease in transbay automobile person-trips (under 3,000 daily trips) together with the large net increase in transit use (over 12,000 daily trips) resulted in a net increase of well over 9,000 daily person-trips in each direction between San Francisco and Oakland during the 14 hours of BART operation. About 2,000 of these "new" trips were made on BART and 7,000 by automobile.

Available evidence suggests that very few of the 7,000 new automobile trips on the San Francisco-Oakland Bay Bridge were diverted from the other bridges. Nor was there a detectable change in traffic occurring outside the hours of BART's operation, nor any decrease in automobile occupancies which could have caused an apparent generation of automobile trips. It is possible that urban development and other events not directly related to the opening of transbay BART service generated new Bay Bridge vehicle traffic over the year. However, traffic levels on the three bridges shortly before the start of transbay BART service suggest that this increase, if any, was much smaller than 7,000 trips per day.

The conclusion remains then, that by adding substantial transportation capacity to the very heavily traveled and often congested Bay Bridge corridor, BART apparently "induced" significant numbers of trips by automobile. These were probably trips which would not have been made as frequently, or would have been made to destinations on the same side of the Bay had it not been for the start of BART service and its resultant (indirect) improvement in Bay Bridge highway travel times.

Improvement in Transbay Highway Service Levels. It had been hypothesized that BART's primary impact on transbay travel would be to improve the level of transit service available, thereby diverting travelers from their automobiles and so reducing highway traffic volumes and peak period traffic congestion. While BART has undoubtedly provided improved transit service to many travelers, it has not reduced highway traffic volumes to the extent expected.

This may be because, indirectly, BART has been effective in improving the level of highway service available in a corridor which was previously capacity-constrained, thereby allowing previously suppressed trips to be made.*

*Whether this should be regarded as a "positive" or "negative" BART impact depends on the relative priorities which are assigned to the conflicting objectives of, on the one hand, providing increased accessibility and mobility to the population (the intrinsic benefits of transportation), and on the other hand, reducing vehicle-miles of travel in order to reduce gasoline consumption, air pollution, and the other external disbenefits of the automobile.

Comparison of Transbay BART Highway Traffic Impacts with Other Systems

It is instructive to compare the BART experience with other recently constructed rapid rail systems in the United States. Two of the most interesting comparisons are with the Philadelphia-Lindenwold High-Speed Line (generally referred to as the Lindenwold Line) and the South Shore Extension of the Massachusetts Bay Transportation Authority (MBTA) rapid transit system in Boston.

The Philadelphia-Lindenwold High-Speed Line. The Lindenwold Line resembles lines of the BART System in several ways. The 14-mile line runs from the suburbs of southern New Jersey to Camden and across the Delaware River into the City of Philadelphia. Six of the system's 12 stations are outside the central city areas, with an average distance of about 1.8 miles between suburban stations.* The maximum operating speed is 75 mph, and the average speed for the entire run from Lindenwold to Philadelphia is 40 mph (compared to an 80 mph maximum and 38 mph average for the BART System). Like BART, train operation is automatically controlled, as is the fare collection system. Trains run around the clock with headways as small as two minutes at rush hours. The line is in a setting similar to that of transbay BART in that highway access to central Philadelphia from the New Jersey suburbs served by the Lindenwold Line is only possible via two heavily traveled bridges over the Delaware River--the Ben Franklin Bridge (which carries the Lindenwold Line tracks) and the Walt Whitman Bridge. Close to 12,000 vehicles typically travel over these bridges in the peak hour (compared to about 9,000 on the San Francisco-Oakland Bay Bridge).

The Lindenwold Line started operation in January 1969. By the end of the first year, about 13,000 trips per weekday were being made in each direction across the Delaware River (compared to 26,000 transbay BART trips in each direction). A survey of the Lindenwold Station (the furthest station from Philadelphia) conducted by the Delaware River Port Authority in October 1969 showed that the previous travel mode of commuters from Lindenwold had been 49% by bus or train and 38% by automobile. Thirteen percent had not traveled previously.** The diversion from automobile was less for stations closer to the City. These results are very close to those obtained in the surveys of transbay BART in which 54% of BART travelers gave bus as the previous mode and 35% automobile.

The impact of the Lindenwold Line on peak period highway traffic congestion has also been similar to BART insofar as the reduction in traffic on the Ben Franklin and Walt Whitman Bridges has been rather less than the diversion of automobile travelers to the Lindenwold Line. The decrease in average weekday traffic on the Ben Franklin Bridge between 1968 and 1969 was about 3,000

*Outside central Oakland, station spacing on the three East Bay lines of the BART System is about 2.9 miles.

**B. Thomas Lofft, The Lindenwold Line: A Case Study of the Newest Rail Rapid Transit, American Automobile Association, Washington, D.C., 1971, p. 8.

vehicles, continuing the trend of the previous two years. (Weekday traffic decreased by 5,800 vehicles between 1966 and 1967; and by 3,000 vehicles between 1967 and 1968.) However, over the peak period (7:00 a.m. to 9:00 a.m.), traffic apparently increased significantly from 1968 to 1969. In summary, available traffic data suggest that the opening of the Lindenwold Line had no detectable effect on peak period highway traffic congestion.*

The South Shore Extension to the MBTA Rapid Transit System. In September 1971, the "South Shore Extension" of Boston's MBTA rapid transit system began service to the cities of Quincy, Milton, Braintree, and Weymouth to the south of Boston. Although only six miles long (and serving three stations), the line forms a useful basis for comparison with BART to the extent that, like BART and the Lindenwold Line, its construction was justified in large part by the promise it held for alleviating peak period traffic congestion. Paralleling the South Shore Line is the Southeast Expressway (Route 3) running from the South Shore suburbs to Boston. At the time of the South Shore Line's opening, this expressway and the parallel Route 3A were heavily used and congested at peak periods. At a screenline at the north end of the South Shore Extension Line, inbound traffic on the Southeast Expressway and Route 3A together averaged about 64,000 vehicles daily in 1971, of which 8,000 were in the peak hour. Surveys conducted in April 1972, eight months after the opening of service, showed that 52% of South Shore Line riders had previously used mass transit, 29% had used automobile, 16% had not made the trip before, and 3% had used some other mode.** These results are similar to both the transbay BART and Lindenwold Line findings.

By December 1971, ridership on the South Shore Line was about 10,000 passengers in each direction, implying a reduction of about 3,000 vehicles per day on the parallel highways. However, no perceptable changes in traffic congestion were recorded on these facilities. The Metropolitan Area Planning Council's report concluded that the transit extension neither reduced inbound average daily traffic, nor reversed the trend of increasing peak hour volumes.

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*In a much more recent paper on the same subject (W. Bruce Allen, "The Impact of the Philadelphia-Lindenwold Rapid Transit Line on Automobile Traffic," Traffic Quarterly, Vol. 28, No. 1, 1974), it is argued that the Lindenwold Line has "definitely decreased automobile travel into center city Philadelphia." This conclusion is different from that quoted above to a large extent, because more recent data show there has been a decrease in peak hour traffic on the Ben Franklin Bridge from 1970 to 1972. However, these data do not invalidate the conclusion that the Lindenwold Line had no detectable effect on peak period traffic levels in the period immediately after the start of service. (In any case, peak period [7:00 a.m.-9:00 a.m.] inbound traffic on the Ben Franklin Bridge was still higher in 1972 than in 1968.)

**South Shore Rail Rapid Transit Extension: Preliminary Impact Study, prepared by the Metropolitan Area Planning Council for the Massachusetts Bay Transportation Authority, October 1973, p. VI-6.

Reasons for Transbay Travel Choices

At the time of the surveys, BART's daily transbay patronage of 26,000 trips in each direction was far below the level predicted.* Although there was a large diversion of passengers from bus to BART (with corresponding reductions in bus service), over 18,000 trips per day in each direction were still being made by bus six weeks after the start of BART service. Similarly, large numbers of travelers who apparently work and live in places easily accessible to BART continued to commute across the Bay Bridge by automobile. The reasons why BART was not attracting a higher ridership are of primary interest.

The comments of transbay travelers themselves give as clear an indication as any of the constraints on BART's current patronage.** Among current automobile travelers, the most frequently mentioned comments about BART concerned the need for improved feeder bus services; the desire for evening and weekend service; dissatisfaction with the degree of crowding on trains at the peak periods, the unreliability of BART, and the shortage of automobile parking spaces at the stations.

Bus travelers, particularly those who continued to use Greyhound buses, also commented frequently on peak period crowding levels and the unreliability of the BART System.

Interestingly, the comments of BART travelers paralleled those of nonusers very closely with regard to their criticisms and suggestions for improvement of BART. Most frequently mentioned were the desire for full evening and weekend service, dissatisfaction with the availability of seats and crowding at peak periods, and dissatisfaction with the reliability of service. The need for improved bus service to BART stations and for increased car parking space at the stations were also mentioned by many current BART travelers. Among Richmond Line travelers, the desire for direct service to Daly City was mentioned frequently. However, it should be emphasized that these criticisms by BART travelers were generally offered in the context of overall satisfaction with BART's service, at what most travelers perceived as being an early stage in the System's development. In particular, the cost, comfort, safety, and security of BART were perceived favorably by the majority of travelers.

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*For example, a BARTD "Background Information" statement released in September 1974, just before the start of BART, estimated a transbay ridership of 42,000 trips in each direction.

**Included in the transbay travel survey of BART, bus, and automobile travelers were sections in which respondents were invited to give their comments about BART or Bay Area transportation generally. Review of these comments provided a number of useful insights into the reasons for the use or nonuse of BART which generally confirmed the conclusions of the more formal analyses of travel behavior and attitudes presented in Chapter VII. Most comments referred favorably to aspects of BART's service, but most also conveyed desires and hopes for improvement in service.

Constraints Imposed by Interim BART Service Levels. The transbay service currently provided by BART is severely limited by available train capacity. At the time of the surveys, BART had accepted less than 350 of its projected fleet of 450 cars; and due to start-up and maintenance problems, less than 60% of these were in revenue service. As a result, less than half of the projected full-service fleet was in service, leading to peak period crowding levels which many potential BART travelers found unacceptable. The relatively high rate of mechanical failure of trains and the limitations of the interim CABS-1 automatic train control system has also given BART a reputation for unreliability, especially among current transbay bus riders.

Constraints Imposed by BART's Access Modes. Resolution of the car availability and reliability problems will undoubtedly increase BART ridership. However, perhaps more importantly, the capacity of the current System is also effectively limited by the availability of access to BART stations. Especially at Daly City and at stations on the Concord Line, the use of BART by those who must use the automobile as the access mode is already constrained by the availability of automobile parking space. Utilization of Fremont Line station parking lots is also already high (particularly at the southernmost stations), and when direct service between Richmond and Daly City is available, it can be expected that utilization of Richmond Line station lots will increase. The fact that station parking lots are full of commuters' cars early in the morning is an especial barrier to the use of BART for nonwork purposes--upon which many hopes for increased BART patronage depend. While AC Transit, MUNI, and others provide bus service to BART from many areas, those BART stations where parking space is limited are also generally those with the poorest feeder bus services. Many people are therefore effectively prevented from using BART.

While it is to be expected that attainment of full, reliable BART service will give rise to a considerable increase in BART's ridership, full realization of BART's passenger-carrying potential ultimately depends on improved access to the System by automobile and bus.

Appendix A

EVALUATION OF SURVEY RESULTS

Appendix A

EVALUATION OF SURVEY RESULTS

Comparison of On-Route and Telephone Survey Results

As a means of checking and, if necessary, compensating for potential non-response biases in the on-route surveys of transbay BART, bus, and automobile travel, a telephone survey of a sample of households in the East Bay was conducted. The sampling frame consisted of all residential telephone numbers listed in the five 1974 telephone directories covering the East Bay BART service area of Contra Costa and Alameda Counties. The survey took place over a three-week period in late October and early November 1974 (around the time of the on-board surveys). The sampling design of the telephone survey allowed interviews with approximately equal samples of (1) households from which a transbay trip had been made the previous day (sample of 305 households) and (2) households from which no transbay trip had been made on the previous day (sample of 380 households).*

Two sets of comparisons can usefully be made based on the telephone survey and on-route survey results:

- Comparisons between the characteristics of transbay and non-transbay trip-making households as revealed by the telephone survey.
- Comparisons between the characteristics of transbay BART, bus, and automobile trip-makers as revealed by the telephone and on-route surveys.

Comparison of Transbay and Nontransbay Trip-Making Households

Table A-1 shows the average household size, average household automobile ownership, race, and family income distribution for transbay trip-making households and nontransbay trip-making households. (Households are categorized as transbay or nontransbay trip-making according to whether one or more transbay trips had been made from the household on the day prior to the telephone interview.)

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*A complete description of the telephone survey methodology is given in: "Surveys of Transbay Travel, October 1974: Data Collection Methodology" BART Impact Program Document Number DD 4-3-75, prepared by Peat, Marwick, Mitchell & Co., Burlingame, California, for the Metropolitan Transportation Commission, Berkeley, California, May 1974.

Table A-1

COMPARISON OF CHARACTERISTICS OF TRANSBAY TRIP-MAKING HOUSEHOLDS AND NONTRANSBAY TRIP-MAKING HOUSEHOLDS

	Transbay Trip-Making Households[a]	Nontransbay Trip-Making Households[b]
Average Household Size	3.4	2.9
Average Household Car Ownership	2.4	1.5
Race:		
White	83%	81%
Spanish-American	3	4
Black	8	11
Oriental	4	2
Other	2	2
Family Income:		
Under $5,000	6%	17%
$ 5,000-$ 9,999	15	29
$10,000-$14,999	24	24
$15,000-$19,999	28	14
$20,000-$24,999	13	9
$25,000 and Over	14	7

a. East Bay households from which one or more transbay trips were made on the day prior to the survey interview. Sample size is approximately 305 households.

b. East Bay households from which no transbay trips were made on the day prior to the survey interview. Sample size is approximately 380 households.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

The table illustrates the generally higher socioeconomic status of transbay travelers. Transbay trip-making households were significantly larger, owned more automobiles (both on a per household and per capita basis), and had higher incomes than nontransbay trip-making households. The racial composition of the two groups of households was not significantly different.

Comparison of Telephone and On-Route Survey Results

Table A-2 shows the socioeconomic characteristics of travelers making transbay trips by BART, bus, and automobile. The results of the on-route surveys are compared with the telephone survey of East Bay households. Sex, race, and distribution of family income are shown.

Distribution of Transbay Trip-Makers by Sex. For all three modes, the on-route survey shows a higher proportion of male transbay trip-makers than the telephone survey. This implies a higher response rate to the on-route survey from men than from women. For none of the modes are the differences in the proportions statistically significant at the 5% significance level. However, if true, they could be explained by the fact that a higher proportion of males tend to be traveling for work or business purposes. In this situation, they may be more amenable to filling out a questionnaire while traveling by transit than females. Also, especially on BART, a higher proportion of males than females appear to be traveling alone--again perhaps increasing the likelihood of their completing a questionnaire.

Distribution of Transbay Travelers by Race. The proportion of trip-makers who are white is also shown as being higher by the on-route surveys than the telephone survey. The differences are not significantly different (at the 5% significance level) for BART or automobile trip-makers. However, for bus trip-makers, the difference is clearly significant at the 5% significance level. This result implies, among bus riders, that minorities (black people, in particular) were significantly underrepresented in the sample of responses to the on-route bus survey.

Income Distribution of Transbay Travelers. Comparison of the distributions of family income for transbay trip-makers using BART, as given in Table A-2, shows the on-route survey and telephone survey results to be very close. Figure A-1 shows that the cumulative distribution of incomes as given by the on-route survey is very close to that for the telephone survey. Statistically speaking, it is also well within the 95% confidence band associated with the telephone survey (telephone survey sample size = 62 transbay BART trips).

Comparison of the two income distributions for bus trip-makers shows that the percentage of respondents in the middle-income ($15,000-$20,000) range was higher for the telephone survey than for the on-route survey. Correspondingly, the on-route survey shows a higher proportion of respondents in the

Table A-2

COMPARISON OF OCTOBER 1974 TELEPHONE AND ON-ROUTE TRANSBAY SURVEY RESULTS

	Percentage Distribution of Characteristics for Transbay Trip-Makers by:					
	BART		Bus		Automobile	
	On-Route Survey	Telephone Survey	On-Route Survey	Telephone Survey	On-Route Survey	Telephone Survey
Sex:						
Male	70%	58%	54%	51%	72%	67%
Female	30	42	46	49	28	33
Race:						
White	89%	86%	80%	63%	87%	85%
Spanish-American	3	2	2	3	2	3
Black	3	--	7	23	5	8
Oriental	4	6	10	9	5	3
Other	1	6	1	2	1	1
Family Income:						
Under $5,000	7%	7%	4%	7%	5%	8%
$ 5,000-$ 9,999	13	16	21	16	12	12
$10,000-$14,999	18	15	21	25	22	24
$15,000-$19,999	20	27	17	30	18	27
$20,000-$24,999	18	12	17	14	17	15
$25,000 and Over	24	23	20	7	26	14

Note: Sample sizes for all three on-route surveys are approximately 2,000 transbay trips. Sample sizes from the telephone survey are: 62 BART trips, 42 bus trips, 208 automobile trips. On-route surveys covered all transbay trips; telephone survey covered only trips made by East Bay residents.

Source: BART Impact Program, October 1974 Surveys of Transbay Travel.

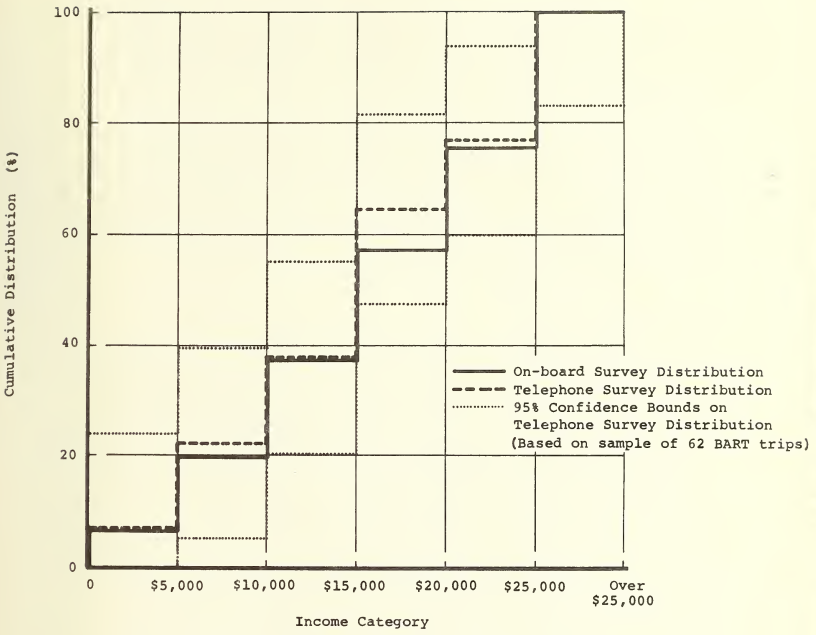


FIGURE A-1

DISTRIBUTION OF FAMILY INCOME FOR TRANSBAY BART TRAVELERS
(COMPARISON OF ON-BOARD AND TELEPHONE SURVEY RESULTS)

Source: • BART Impact Program, October 1974 Surveys of Transbay Travel

"$20,000 and over" income categories. Significantly, the proportions of respondents in the low-income (under $10,000) category are very close. As shown in Figure A-2, overall, the cumulative distribution of incomes revealed by the on-route survey is within the 95% confidence band of the telephone survey distribution (telephone survey sample size = 42 transbay bus trips).

Comparison of the family income distributions of transbay automobile trip-makers given in Table A-2 shows that a higher proportion of high-income (over $25,000) respondents is indicated by the on-route survey than by the telephone survey. Otherwise, and especially for the lower income categories (under $15,000), the two distributions are very close. Figure A-3 confirms that the cumulative income distribution derived from the on-route survey is outside the 95% confidence band for the higher income categories (telephone survey sample size = 208 transbay automobile trips).

Conclusions

Mail-back types of questionnaire surveys in which response rates are far below 100% are generally suspected to be biased mainly because persons from higher socioeconomic levels are more likely to fill in and return a questionnaire than those of lower socioeconomic level. Taking the results of the telephone survey as the basis for comparison, there do appear to be differences in response rates to the on-route surveys as a function of socio-economic status insofar as this is correlated with race and income. However, in nearly all cases, the differences are small and statistically speaking not significant. It should be acknowledged that this lack of significance may be attributable in part to the small sample sizes, especially of transbay bus and BART travelers, obtained in the telephone survey. But even where the differences are statistically significant overall (as in the income distribution for automobile transbay trip-makers), the "low ends" of the distributions tend to be similar. It appears that black people are significantly underrepresented in the response to the on-route bus survey, but the potential bias associated with this may be offset to some extent by the fact that the income distributions shown by the on-route and telephone survey are very close. Importantly, the traveler profile revealed by responses to the BART on-route survey conform very closely to that revealed by the telephone survey in all respects.

Overall, it is felt that the above comparisons with the telephone survey results do not lead to a conclusion that the on-route survey results are biased enough to require correction.

Comparison of BART On-Route and BART Observational Census Survey Results

In conjunction with the questionnaire handout survey of BART travelers conducted on October 30, 1974, an observational census of BART travelers entering 24th Street-Mission, and Daly City BART Stations was conducted. The census covered

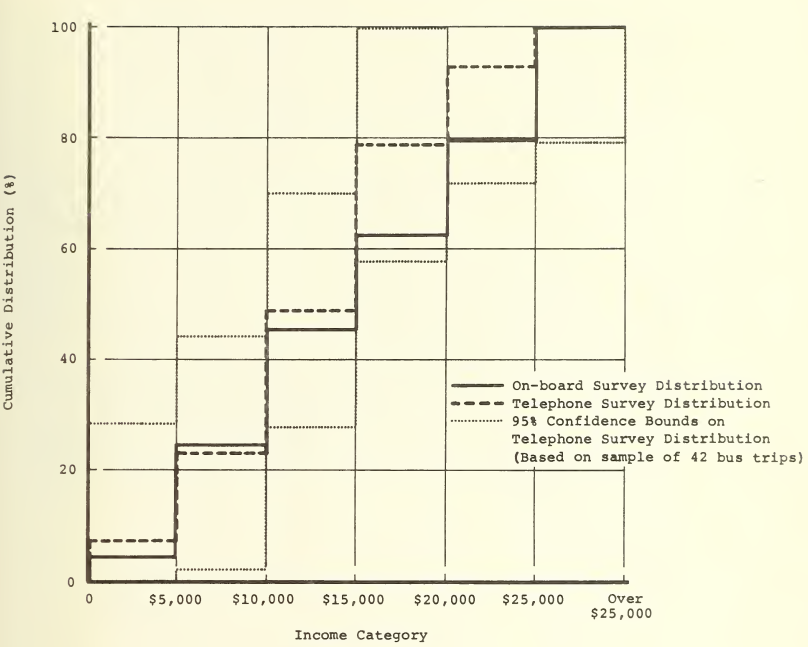


FIGURE A-2

DISTRIBUTION OF FAMILY INCOME FOR TRANSBAY BUS TRAVELERS
(COMPARISON OF ON-BOARD AND TELEPHONE SURVEY RESULTS)

Source: • BART Impact Program, October 1974 Surveys of Transbay Travel

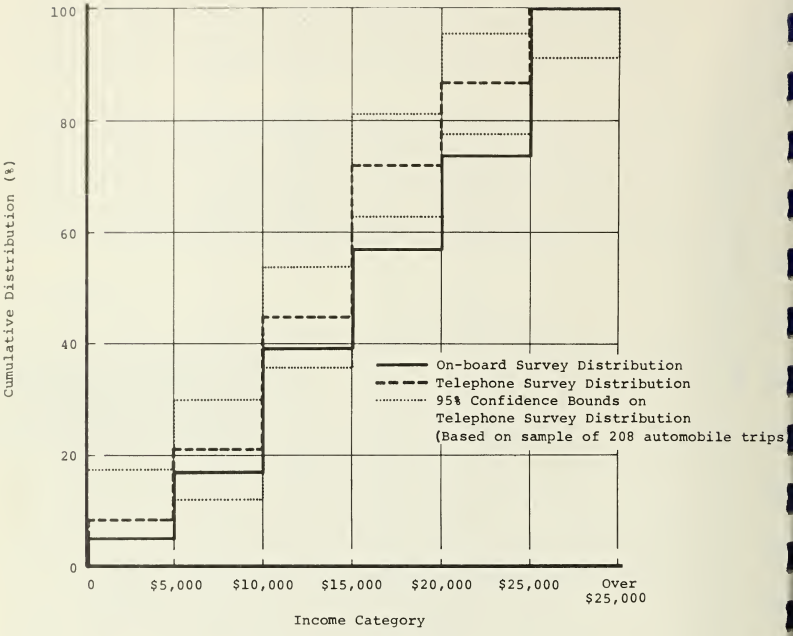


FIGURE A-3

DISTRIBUTION OF FAMILY INCOME FOR TRANSBAY AUTOMOBILE TRAVELERS
(COMPARISON OF ON-BOARD AND TELEPHONE SURVEY RESULTS)

Source: • BART Impact Program, October 1974 Surveys of Transbay Travel

the full day of BART operation (6:00 a.m. to 8:00 p.m.) and involved observation of a sample of about 3,600 people entering the stations (either traveling on the San Francisco Line or transbay). As part of this census, the sex and race of travelers was observed. Results of the census are given in Table A-3. Also given in Table A-3 are the corresponding results from the October 1974 BART Impact Program on-route survey of transbay BART travel and the May 1974 BARTD Passenger Profile Survey of BART passengers traveling within San Francisco.

When interpreting these figures, it must be borne in mind that individual census takers performed the classification by race on the basis of observation alone, and therefore, the census takers' personal judgments and classification criteria are inevitably reflected.

It must also be emphasized that the populations surveyed are different in the three cases. The May 1974 Passenger Profile Survey was conducted before the opening of the transbay link and includes only San Francisco Line travelers. The October 1974 BART Impact Program survey included only transbay travelers. The October 1974 census included both San Francisco and transbay travelers.

In October 1974, only about 13% of travelers entering the Daly City Station were traveling across the Bay. At 24th Street-Mission, the figure was 32%. Thus, it was expected that the observational census results would be closer to the May 1974 San Francisco survey results than to the October 1974 transbay survey results. Taking this into account, the results of the census and on-route survey results are quite close and serve to support the validity of the on-route survey results.

Table A-3

RACE AND SEX OF BART TRAVELERS ENTERING 24th STREET-MISSION AND DALY CITY STATIONS
(Comparison of BART Observational Census and On-Route Survey Results)

BART Passengers Entering:	October 1974 Observational Census of San Francisco and Transbay BART Travelers	October 1974 BART Impact Program On-Route Survey of Transbay BART Travelers	May 1974 BARTD Passenger Profile Survey of San Francisco BART Travelers
24th Street-Mission			
Race			
White	72%	71%	70%
Black	5	5	3
Other	23	24	27
Sex			
Male	56%	64%	47%
Female	44	36	53
Daly City			
Race			
White	75%	80%	71%
Black	10	7	7
Other	15	13	22
Sex			
Male	47%	78%	44%
Female	53	22	56

Appendix B

ORIGINS AND DESTINATIONS OF TRANSBAY TRIPS

Table B-1

TRANSBAY BART TRAVEL - ALL TRIP PURPOSES

WEST BAY ZONES

EAST BAY ZONES	(1) MARIN COUNTY	(2) SAN FRANCISCO DOWNTOWN *	(3) SAN FRANCISCO CIVIC CENTER	(4) SAN FRANCISCO NORTHEAST	(5) SAN FRANCISCO NORTHWEST	(6) THE AVENUES	(7) TWIN PEAKS *	(8) MISSION *	(9) PITTSBURG-BAYVIEW	(10) MCLAREN PARK *	(11) PARK MERCED	(12) DALY CITY *	(13) SOUTH SAN FRANCISCO	(14) SAN MATEO	(15) REDWOOD CITY	(16) PALO ALTO	(17) [illegible]	OTHER	TOTAL
(18) PLEASANTON-LIVERMORE	0	0	200	0	0	0	0	0	200	0	0	0	0	0	0	0	0	100	400
(19) FREMONT *	0	800	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200
(20) HAYWARD *	0	400	300	0	100	0	0	100	100	0	0	0	0	0	0	0	0	200	1200
(21) SAN LEANDRO *	0	500	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	1000
(22) OAKLAND * SOUTH	0	200	400	0	0	0	0	0	0	100	100	0	0	0	0	0	0	200	1100
(23) DANVILLE	0	300	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500
(24) ORINDA- * LA FAYETTE	0	1600	700	100	0	0	0	0	100	0	0	0	0	0	0	0	0	100	2600
(25) WALNUT * CREEK	0	1700	900	0	0	100	0	0	100	0	0	0	0	0	0	0	0	100	3100
(26) CONCORD *	0	2100	800	0	0	100	100	0	100	0	0	0	0	0	0	0	0	200	3600
(27) CROCKETT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
(28) RICHMOND- * EL CERRITO	0	300	300	0	100	0	0	0	0	0	0	0	0	0	0	0	0	200	900
(29) ALAMEDA	0	200	200	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	600
(30) BERKELEY *	0	600	800	300	100	200	400	300	0	100	400	200	0	0	0	0	0	100	3600
(31) OAKLAND * NORTH	0	300	200	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	900
(32) PIEDMONT	0	300	300	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	800
(33) ALAMEDA	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300
(34) OAKLAND * WEST	0	100	200	0	100	0	100	100	0	0	0	0	0	0	0	0	0	100	900
(35) BENICIA SOUTH	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	300
(36) BENICIA EAST	0	100	300	100	0	0	0	0	0	0	0	0	0	0	0	0	0	100	700
(37) OAKLAND * DOWNTOWN	0	200	300	0	100	0	200	0	0	0	100	100	0	100	0	0	0	200	1400
(38) TREASURE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER	0	200	300	0	100	0	0	0	0	0	0	0	0	0	0	0	0	200	900
TOTAL	0	10200	7000	800	500	700	1300	800	700	400	800	500	200	200	0	0	0	1900	28100

OTHER ZERO ENTRIES INDICATE LESS THAN 50 DAILY TRIPS

* ZONE CONTAINS MORE STATION OR STATIONS

SEE ADDITIONAL NOTES FOLLOWING

Table B-2

TRANSBAY BUS TRAVEL - ALL TRIP PURPOSES

WEST BAY ZONES

EAST BAY ZONES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	TOTAL
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*	0	300	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
*	0	400	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
*	0	300	100	0	0	100	0	0	0	0	0	0	0	0	0	0	0	200
	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*	0	400	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*	0	1200	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
*	0	500	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*	0	1100	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300
	0	800	200	100	100	0	0	0	0	0	0	0	0	0	0	0	0	100
*	0	1200	400	300	100	200	200	100	0	0	0	0	0	0	0	0	0	200
*	0	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
	0	1100	300	100	0	0	0	0	0	0	0	0	0	0	0	0	0	200
	0	900	200	0	0	0	0	100	0	0	0	0	0	0	0	0	0	200
*	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	200	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
	0	500	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
*	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	200	100	0	0		0	0	0	0	0	0	0	0	0	0	0	100
	0	9800	2500	700	300	400	300	100	400	100	200	0	0	0	0	0	0	2100

Table B-3

TRANSBAY AUTO TRAVEL - ALL TRIP PURPOSES

EAST BAY ZONES	WEST BAY ZONES: (1) MARIN COUNTY	(2) SAN FRANCISCO DOWNTOWN*	(3) SAN FRANCISCO CIVIC CENTER	(4) SAN FRANCISCO NORTH-EAST	(5) SAN FRANCISCO NORTH	(6) THE AVENUES	(7) TWIN PEAKS*	(8) MISSION*	(9) POTRERO-BAYVIEW	(10) MCLAREN PARK*	(11) LAKE MERCED	(12) DALY CITY*	(13) SOUTH SAN FRANCISCO	(14) SAN MATEO	(15) REDWOOD CITY	(16) PALO ALTO	(17) TREASURE ISLAND	OTHER	TOTAL
(18) PLEASANTON-LIVERMORE	0	300	500	100	0	100	0	0	300	0	0	0	0	0	0	100	200	1400	
(19) FREMONT*	0	300	300	200	0	0	0	0	0	0	0	0	100	0	0	100	100	1200	
(20) HAYWARD*	0	400	400	200	100	200	100	0	200	0	0	0	100	0	0	100	200	2100	
(21) SAN LEANDRO*	0	500	100	500	100	200	200	100	100	200	100	100	200	0	0	100	400	2600	
(22) OAKLAND* SOUTH	200	1200	1100	400	200	600	500	200	300	100	300	100	200	200	0	0	400	600	6600
(23) DANVILLE	0	400	400	0	200	0	0	0	100	0	100	100	100	0	0	0	0	300	1500
(24) ORINDA-* LA FAYETTE	0	2400	1000	200	200	200	200	100	200	100	100	100	600	300	0	0	0	600	6200
(25) WALNUT* CREEK	200	2100	1500	400	200	200	100	0	600	0	0	0	500	200	0	0	100	700	6800
(26) CONCORD*	300	1000	1000	200	200	200	100	200	200	100	800	0	300	200	100	100	300	700	6100
(27) CROCKETT	0	100	100	0	0	0	0	0	200	0	200	100	200	0	0	0	0	0	1000
(28) RICHMOND-* EL CERRITO	0	1100	600	600	700	400	200	0	200	100	400	300	400	200	0	200	100	300	5700
(29) ALBANY	0	1000	800	300	200	400	300	200	100	300	100	0	0	100	0	0	200	400	4600
(30) BERKELEY*	100	1300	700	1200	700	1800	1000	400	400	200	800	300	600	400	200	400	0	900	11300
(31) OAKLAND* NORTH	100	1000	1100	700	600	600	200	300	400	100	400	100	400	100	0	0	100	1000	7200
(32) PIEDMONT	0	1200	1200	500	400	300	500	0	300	100	500	0	300	100	100	100	0	600	6000
(33) ALAMEDA	100	700	500	200	200	200	200	0	200	100	400	200	400	100	0	0	400	300	4200
(34) OAKLAND* WEST	100	800	200	400	200	100	400	100	0	200	200	200	400	200	200	0	500	100	4200
(35) MERRITT SOUTH	0	200	0	200	0	100	100	0	100	200	100	0	0	0	0	0	0	0	1000
(36) MERRITT EAST	200	500	400	300	200	200	100	0	100	100	100	0	100	0	0	0	0	400	2700
(37) OAKLAND* DOWNTOWN	300	200	300	300	300	400	200	100	0	0	0	0	0	100	0	0	0	0	2100
(17) TREASURE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	100
OTHER	0	1000	900	600	500	500	800	0	300	100	200	200	400	400	100	0	100	1400	7600
TOTAL	1700	17600	13200	7600	5200	6400	5300	1700	4300	2100	4700	1800	5300	2500	800	800	2500	9000	92400

NOTE: ZERO ENTRIES INDICATE LESS THAN 50 DAILY TRIPS

* ZONE CONTAINS BART STATION OR STATIONS

SEE ADDITIONAL NOTES FOLLOWING

Table B-4

TRANSBAY TRAVEL BY ALL MODES - ALL TRIP PURPOSES

WEST BAY ZONES

EAST BAY ZONES

	(1) MARIN COUNTY	(2) SAN FRANCISCO DOWNTOWN *	(3) SAN FRANCISCO CIVIC CENTER	(4) SAN FRANCISCO NORTH-EAST	(5) SAN FRANCISCO NORTH	(6) THE AVENUES	(7) TWIN PEAKS *	(8) MISSION *	(9) POTRERO-BAYVIEW	(10) MCLAREN PARK *	(11) PARK MERCED	(12) DALY CITY *	(13) SOUTH SAN FRANCISCO	(14) SAN MATEO	(15) REDWOOD CITY	(16) PALO ALTO	(17) TREASURE ISLAND	OTHER	TOTAL
(18) PLEASANTON-LIVERMORE	0	300	700	100	0	100	0	0	400	0	0	0	0	0	0	0	100	200	1900
(19) FREMONT *	0	1100	700	200	0	0	0	0	100	0	0	0	100	0	0	0	100	100	2500
(20) HAYWARD *	0	1000	800	200	200	300	100	100	200	0	0	100	100	0	0	0	100	500	3800
(21) SAN LEANDRO *	0	1400	400	500	200	200	200	100	100	300	100	100	200	0	0	0	100	500	4300
(22) OAKLAND SOUTH *	200	1800	1600	400	200	700	600	200	400	200	400	100	300	200	0	0	400	1000	8500
(23) DANVILLE	0	900	600	100	200	0	0	0	100	0	100	100	100	0	0	0	0	300	2300
(24) ORINDA-LA FAYETTE *	0	4500	1800	400	200	200	200	100	300	100	100	100	600	300	0	0	0	600	9400
(25) WALNUT CREEK *	200	5100	2500	500	200	200	100	100	800	0	0	0	500	200	0	0	100	900	11400
(26) CONCORD *	300	3600	1900	300	200	300	200	300	300	100	800	0	300	200	100	100	300	900	10300
(27) CROCKETT	0	200	100	0	0	0	0	0	200	0	200	100	200	0	0	0	0	0	1200
(28) RICHMOND-EL CERRITO *	0	2500	1200	700	800	400	200	100	300	100	500	300	400	200	0	200	100	800	8500
(29) ALBANY	0	2000	1300	400	300	500	300	200	100	300	200	0	0	100	100	0	200	600	6600
(30) BERKELEY *	100	3000	1900	1800	900	2200	1700	700	500	300	1200	500	600	400	200	400	0	1200	17700
(31) OAKLAND NORTH *	100	1900	1300	800	600	600	300	300	400	100	500	100	400	100	0	0	100	1100	8800
(32) PIEDMONT	0	2600	1800	600	500	300	600	100	300	100	500	0	300	100	100	100	0	800	8700
(33) ALAMEDA	100	1400	700	200	200	200	300	0	300	100	400	200	400	100	0	0	400	600	5700
(34) OAKLAND WEST *	100	1000	400	500	200	200	500	200	0	300	300	200	400	200	200	0	500	200	5200
(35) MERRITT SOUTH	0	400	200	200	0	100	100	0	200	200	100	0	0	0	0	0	0	100	1800
(36) MERRITT EAST	200	1200	900	400	200	200	200	0	100	100	100	0	100	0	0	0	0	600	4200
(37) OAKLAND DOWNTOWN *	300	500	600	400	400	400	400	100	0	0	100	100	0	200	0	0	0	200	3700
(17) TREASURE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	100
OTHER	0	1400	1300	600	600	500	800	0	300	200	200	300	400	400	100	0	100	1700	9000
TOTAL	1700	37700	22800	9000	6100	7500	6900	2600	5400	2600	5600	2300	5500	2700	800	800	2500	13000	135600

NOTE: [illegible] INDICATE LESS THAN [illegible] DAILY TRIPS

* [illegible] STATIONS

[illegible] ADDITIONAL NOTES FOLLOWING

Table B-5

TRANSBAY BART TRAVEL - WORK TRIPS

EAST BAY ZONES	WEST BAY ZONES: (1) MARIN COUNTY	(2) SAN FRANCISCO DOWNTOWN*	(3) SAN FRANCISCO CIVIC CENTER	(4) SAN FRANCISCO NORTHEAST	(5) SAN FRANCISCO NORTH	(6) THE AVENUES	(7) TWIN PEAKS*	(8) MISSION*	(9) POTRERO-MARKET	(10) MCLAREN PARK*	(11) PARK MERCED	(12) DALY CITY*	(13) SOUTH SAN FRANCISCO	(14) SAN MATEO	(15) REDWOOD CITY	(16) PALO ALTO	(17) PENINSULA [illegible]	OTHER	
(18) PLEASANTON-LIVERMORE	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200
(19) FREMONT*	0	700	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1100
(20) HAYWARD*	0	300	300	0	0	0	0	100	0	0	0	0	0	0	0	0	0	100	900
(21) SAN LEANDRO*	0	400	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	600
(22) OAKLAND* SOUTH	0	200	200	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	700
(23) DANVILLE	0	300	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500
(24) ORINDA-* LA FAYETTE	0	1500	600	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	2300
(25) WALNUT* CREEK	0	1700	700	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	2600
(26) CONCORD*	0	2100	700	0	0	0	0	100	0	0	0	0	0	0	0	0	0	200	3300
(27) CROCKETT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
(28) RICHMOND-* EL CERRITO	0	100	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	500
(29) ALBANY	0	200	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300
(30) BERKELEY*	0	500	300	100	0	100	100	100	0	0	100	100	0	0	0	0	0	0	1400
(31) OAKLAND* NORTH	0	200	100	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	500
(32) PIEDMONT	0	200	200	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	600
(33) ALAMEDA	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200
(34) OAKLAND* WEST	0	100	100	0	0	0	100	100	0	0	0	0	0	0	0	0	0	100	500
(35) MERRITT SOUTH	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200
(36) MERRITT EAST	0	100	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400
(37) OAKLAND* DOWNTOWN	0	100	0	0	100	0	100	0	0	0	0	100	0	100	0	0	0	100	700
(17) TREASURE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER	0	200	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400
TOTAL	0	9200	4700	300	200	300	700	500	500	200	300	300	200	100	0	0	0	700	18300

NOTE: ZERO ENTRIES INDICATE LESS THAN 50 DAILY TRIPS

* ZONE CONTAINS BART STATION OR STATIONS

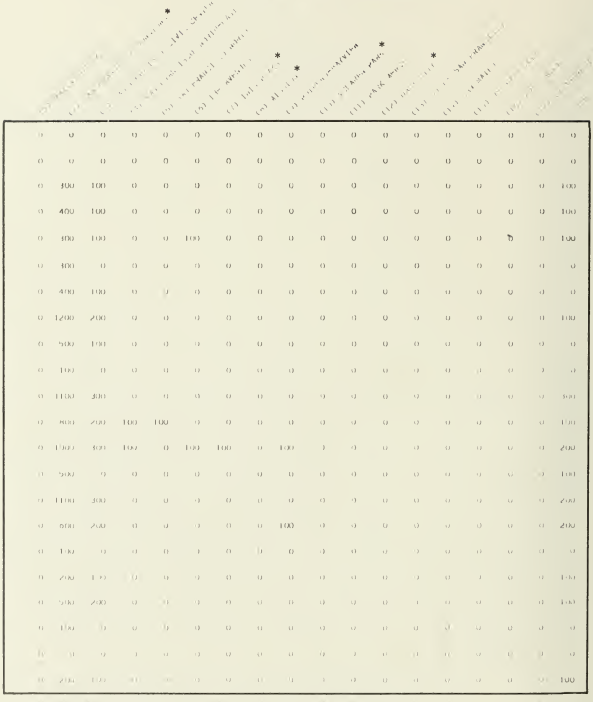
SEE ADDITIONAL NOTES FOLLOWING

Table B-6

TRANSBAY BUS TRAVEL - WORK TRIPS

WEST BAY ZONES

EAST BAY ZONES



B-8

Table B-7

TRANSBAY AUTO TRAVEL - WORK TRIPS

WEST BAY ZONES

EAST BAY ZONES	(1) MARIN COUNTY	(2) SAN FRANCISCO DOWNTOWN*	(3) SAN FRANCISCO CIVIC CENTER	(4) SAN FRANCISCO NORTHEAST	(5) SAN FRANCISCO NORTHEAST	(6) THE AVENUES	(7) TWIN PEAKS*	(8) MISSION*	(9) POTRERO-HAYES	(10) MISSION PARK*	(11) PARK MERCED	(12) DALY CITY*	(13) SOUTH SAN FRANCISCO	(14) SAN MATEO	(15) REDWOOD CITY	(16) PALO ALTO	(17) SAN JOSE	(18) SANTA CRUZ	TOTAL
(39) RICHMOND-EL CERRITO*	0	300	300	100	0	0	0	0	300	0	0	0	0	0	0	0	100	0	1200
(40) PIEDMONT*	0	300	300	200	0	0	0	0	0	0	0	0	0	0	0	0	100	100	1300
(41) HAYWARD*	0	300	300	100	100	0	100	0	100	0	0	0	100	0	0	0	100	0	1300
(42) SAN LEANDRO*	0	300	100	200	100	100	100	0	100	200	0	100	0	0	0	0	100	200	1600
(43) OAKLAND* SOUTH	0	600	900	200	200	300	500	100	300	100	100	100	200	100	0	0	200	200	4100
(44) DANVILLE	0	400	300	0	0	0	0	0	100	0	100	0	100	0	0	0	0	100	1000
(45) ORINDA-* LAFAYETTE	0	2200	800	200	0	0	0	0	200	100	0	0	300	0	0	0	0	400	4200
(46) WALNUT* CREEK	0	1800	1100	200	100	0	100	0	400	0	0	0	200	100	0	0	100	400	4600
(47) CONCORD*	100	900	700	200	200	200	0	200	200	100	200	0	300	100	0	0	200	300	3900
(48) CROCKETT	0	100	100	0	0	0	0	0	200	0	100	100	0	0	0	0	0	0	700
(49) RICHMOND-* EL CERRITO	0	700	400	300	700	300	200	0	200	100	300	100	100	100	0	100	100	100	3700
(50) ALAMEDA	0	800	700	200	100	200	200	100	100	300	0	0	0	100	0	0	200	100	3200
(51) BERKELEY*	100	800	400	500	400	1000	500	200	300	0	500	100	200	300	0	0	0	200	5500
(52) OAKLAND* NORTH	0	500	700	400	200	300	200	200	200	100	300	100	100	100	0	0	100	500	3900
(53) PIEDMONT	0	1000	1000	300	300	100	500	0	200	100	200	0	200	0	0	0	0	100	4100
(53) ALAMEDA	100	500	300	200	0	100	100	0	200	0	300	200	300	100	0	0	400	100	3200
(54) OAKLAND* WEST	100	100	100	200	200	0	400	100	0	200	200	200	300	200	0	0	300	0	2700
(55) MERRITT SOUTH	0	100	0	100	0	0	100	0	100	0	0	0	0	0	0	0	0	0	500
(56) MERRITT EAST	0	200	300	200	100	0	100	0	100	100	100	0	100	0	0	0	0	0	1500
(57) OAKLAND* DOWNTOWN	100	0	0	300	300	200	200	100	0	0	0	0	0	0	0	0	0	0	1100
(58) TREASURE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	100
OTHER	0	500	200	400	200	100	500	0	200	100	200	200	400	200	100	0	0	400	3700
TOTAL	500	12300	9200	4600	3200	3200	3800	1300	3300	1700	2500	1200	2800	1400	200	200	1900	3300	56800

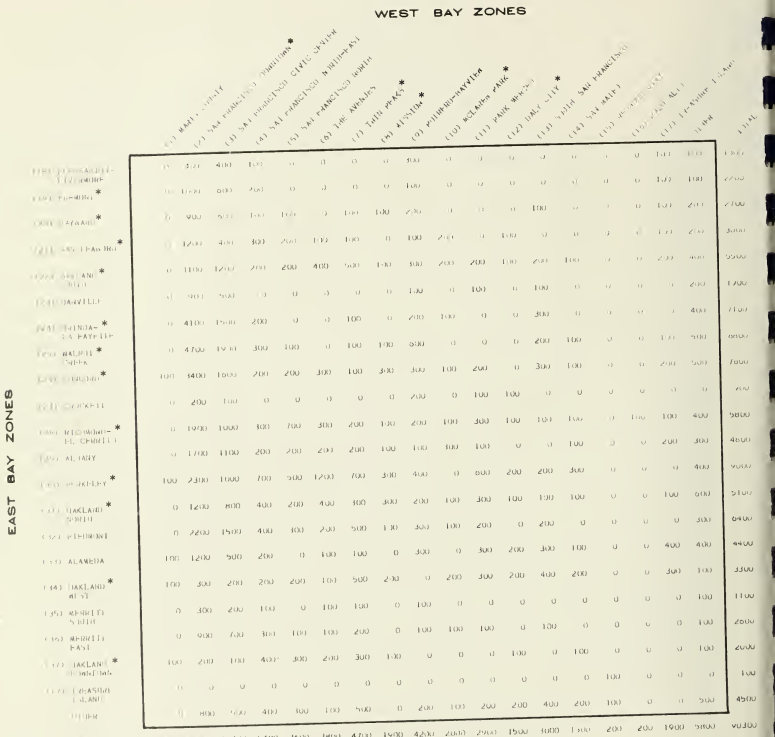
SOME ZONE TOTALS INDICATE LESS THAN 50 DAILY TRIPS

* ZONE CONTAINS RAIL STATION OR STATIONS

SEE ADDITIONAL NOTES FOLLOWING

Table B-8

TRANSBAY TRAVEL BY ALL MODES - WORK TRIPS



* ADDITIONAL NOTES FOLLOWING

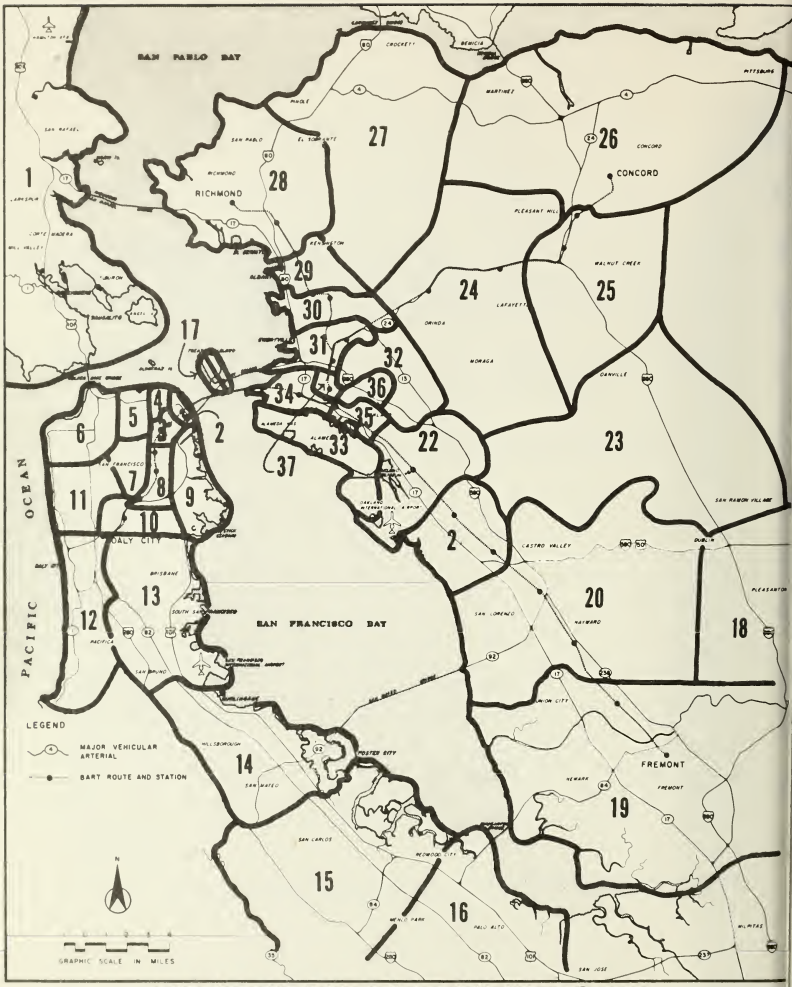
NOTES TO TABLES B-1 THROUGH B-8

1. Definitions of origin and destination zones are illustrated in Figure B-1 and Table B-9.

2. Values are estimates of daily one-way person trips for midweek transbay travel between 6:00 a.m. and 8:00 p.m. The estimates were derived from surveys of transbay travel conducted on Wednesday, October 30, 1974. BART and bus travel were surveyed in the eastbound direction; automobile travel was surveyed in the westbound direction.

3. Figures are rounded to the nearest 100 trips. Trip estimates of less than 50 are shown as zero. Consequently, row or column elements do not necessarily sum to the totals shown.

4. Values shown in Tables B-5 through B-8 include all trips made for work purposes, both home-based and nonhome-based.



• See Appendix Table B-9 for definition of zones

FIGURE B-1

ANALYSIS ZONES FOR TRANSBAY TRAVEL

Table B-9

DEFINITION OF ZONES USED IN ORIGIN-DESTINATION TABULATIONS

WEST BAY ZONES

1. Marin County

2. San Francisco Downtown

   The financial and central business district: From Kearny Street to Embarcadero north of Market Street; from Third Street to Embarcadero south of Market Street. Contains the Montgomery Street BART Station.

3. San Francisco Civic Center

   Four to seven blocks north and south of Market Street, from Third Street in the east to Dolores Street in the west. Includes the Civic Center, Nob Hill, and Union Square. Contains the Powell Street and Civic Center BART Stations.

4. San Francisco North-East

   Two contiguous areas: One bounded by Laguna, Eddy, Jones, and Jackson Streets; the second bounded by Jackson and Sansome Streets, Embarcadero, and Van Ness Avenue.

5. San Francisco North

   The area west of Zone 4 bounded by McAllister, Presidio, Pacific, and Lyon Streets, and the Marina Green.

6. The Avenues

   Northwest area of San Francisco including the Richmond and Sunset districts, Golden Gate Park, and the Presidio.

7. Twin Peaks

   Includes the Diamond Heights, Parnassus Heights, and Haight Ashbury districts. Contains the Glen Park BART Station.

8. Mission

   Contains 16th Street-Mission and 24th Street-Mission BART Stations.

9. Potrero-Bayview

   The area to the south of the downtown and Civic Center zones including the Hunters Point district.

Table B-9 (Cont.)

DEFINITIONS OF ZONES USED IN ORIGIN-DESTINATION TABULATIONS

WEST BAY ZONES (Cont.)

10. McLaren Park

The southern area of San Francisco including the Ocean View, outer Mission, and Visitacion Valley districts. Contains the Balboa Park BART Station.

11. Park Merced

The southwestern area of San Francisco including the Park Merced, St. Francis Wood, and Parkside districts.

12. Daly City

Consists of Daly City, Colma, and Pacifica. Contains the Daly City BART Station.

13. South San Francisco

Consists of Brisbane, South San Francisco, San Bruno, and the San Francisco International Airport.

14. San Mateo

Consists of Millbrae, Burlingame, Hillsborough, San Mateo, and Foster City.

15. Redwood City

Consists of Belmont, San Carlos, Redwood City, and Woodside.

16. Palo Alto

Consists of Menlo Park, Atherton, Portola Valley, Stanford University, Palo Alto, Mountain View, Los Altos, Cupertino, and La Honda.

17. Treasure Island

Consists of Treasure Island and Yerba Buena Island (between San Francisco and Oakland).

Other (West Bay)

Includes areas of the San Francisco Peninsula not included in other West Bay zones, San Jose, and any other origins or destinations outside the San Francisco Bay Area.

Table B-9 (Cont.)

DEFINITIONS OF ZONES USED IN ORIGIN-DESTINATION TABULATIONS

EAST BAY ZONES

18. Pleasanton-Livermore

Includes Pleasanton, Dublin, San Ramon Village, and Livermore.

19. Fremont

Includes Fremont, Newark, and Union City. Contains the Fremont and Union City BART Stations.

20. Hayward

Includes Hayward and Castro Valley. Contains the Hayward and South Hayward BART Stations.

21. San Leandro

Consists of San Leandro and San Lorenzo. Contains the San Leandro and Bay Fair BART Stations.

22. Oakland South

Includes Oakland International Airport and is bounded by the Bay, the San Leandro city limits, Redwood Road, and 35th Avenue. Contains the Coliseum and Fruitvale BART Stations.

23. Danville

Includes Danville and Diablo; also runs south to include the northern segment of San Ramon Village.

24. Orinda-Lafayette

Includes Orinda, Moraga, Lafayette, and western parts of Pleasant Hill. Contains the Orinda and Lafayette BART Stations.

25. Walnut Creek

Includes Walnut Creek, Rossmoor, Alamo, and southern parts of Pleasant Hill. Contains the Walnut Creek and Pleasant Hill BART Stations.

26. Concord

Includes Concord, most of Pleasant Hill, Pacheco, Martinez, Port Chicago, and Pittsburg. Contains the Concord BART Station.

27. Crockett

Includes Pinole, Rodeo, Crockett, Port Costa, and the Mare Island Naval Shipyard.

Table B-9 (Cont.)

DEFINITIONS OF ZONES USED IN ORIGIN-DESTINATION TABULATIONS

EAST BAY ZONES (Cont.)

28. Richmond/El Cerrito

    Includes El Sobrante, San Pablo, Richmond, and El Cerrito. Contains the Richmond, El Cerrito del Norte, and El Cerrito Plaza BART Stations.

29. Albany

30. Berkeley

    Consists of Berkeley including the University of California. Contains the Ashby, Berkeley, and North Berkeley BART Stations.

31. Oakland North

    Area bordered by 28th Street, Broadway, Broadway Terrace, and the Berkeley city limits including Emeryville. Contains the MacArthur and Rockridge BART Stations.

32. Piedmont

    Includes most of the City of Piedmont plus an area of Oakland bounded by Park Boulevard, the Warren Freeway, Highway 24, Skyline Boulevard, Redwood Road, 35th Avenue, and Interstate 580.

33. Alameda

    Consists of the City of Alameda including a portion of Bay Farm Island and the U.S. Naval Air Station.

34. Oakland West

    The area bounded by 28th Street, West Street, 12th Street, and Laney College, including a majority of the Port of Oakland, the U.S. Naval Supply Center, and Oakland Army Base. Contains the Lake Merritt and Oakland West BART Stations.

35. Merritt South

    The area south of Lake Merritt bounded by Lake Merritt, Interstate 580, and 23rd Avenue.

36. Merritt East

    The area bounded by the east shore of Lake Merritt, Harrison Street, Oakland Avenue, the City of Piedmont, Park Boulevard, and Interstate 580. It's eastern border includes areas of Piedmont.

Table B-9 (Cont.)

DEFINITIONS OF ZONES USED IN ORIGIN-DESTINATION TABULATIONS

EAST BAY ZONES (Cont.)

37. Oakland Downtown

The area bounded by the west shore of Lake Merritt, 27th Street, West Street, and 12th Street. Contains the Oakland 12th Street and Oakland 19th Street BART Stations.

Other (East Bay)

Includes Napa and Solano Counties, the Antioch-Brentwood area, the Sacramento Valley, San Jose, and any other origins or destinations outside the San Francisco Bay Area.